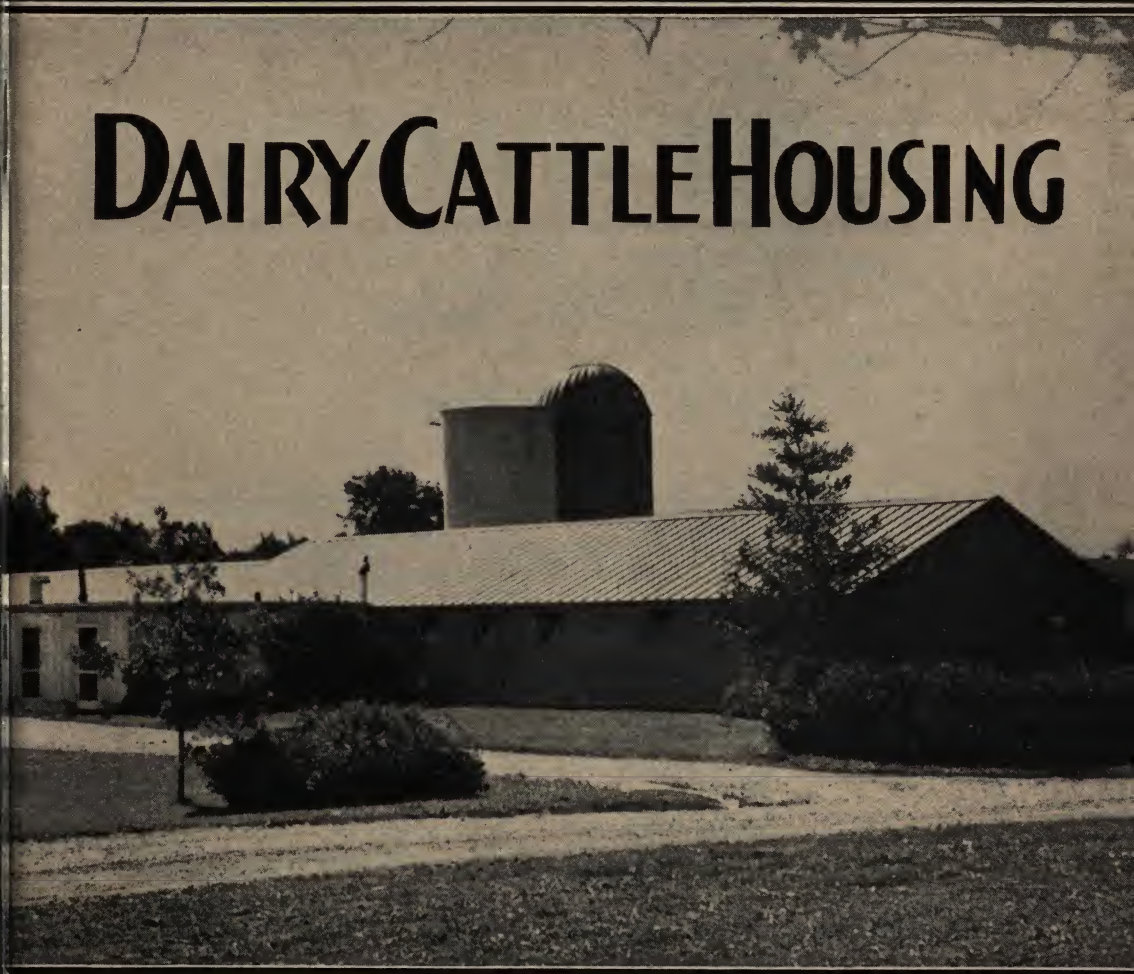
BULLETIN 470 (REGIONAL BULLETIN 7) SEPT. 1946 (REVISED SEPT. 1949)
REVISED OCTOBER 1950

DAIRY CATTLE HOUSING



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AGRICULTURAL EXPERIMENT STATION
University of Wisconsin — MADISON

A Contribution from the Dairy Cattle Housing Sub-Committee of the North Central Region Farm Structures Coordinating Committee

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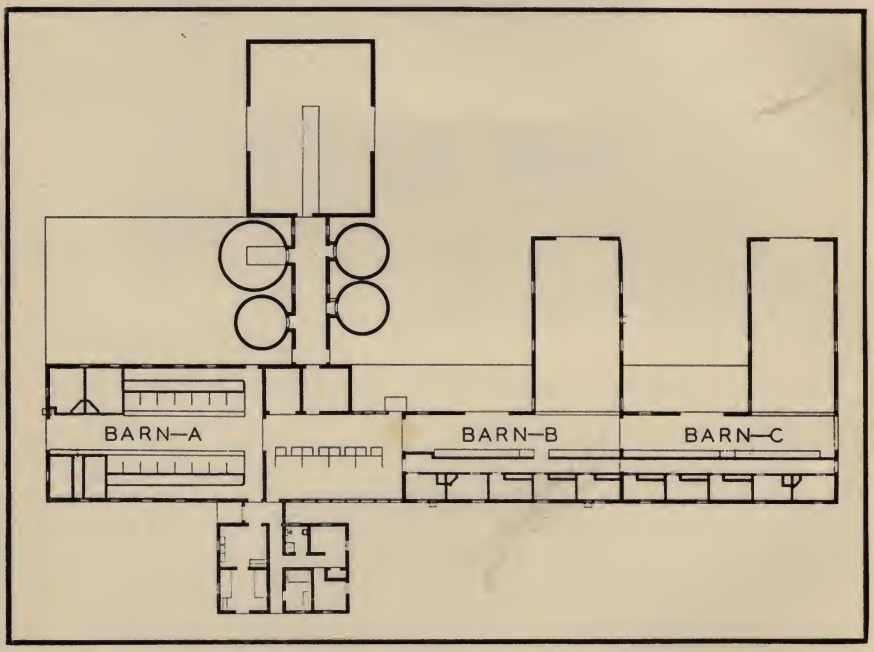

Fig. 1—The Dairy Barn Research Project, now in its eighth year of operation, carried on cooperatively by the University of Wisconsin and the Carnegie–Illinois Steel Corporation and with the aid of regional funds from the Agricultural Research and Marketing Act, compares the performance of dairy herds in A—Insulated stanchion barn; B—Insulated loose housing barn; C—Non-insulated, open, loose housing barn.

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DAIRY CATTLE HOUSING

MANY DAIRYMEN are faced with the problem of remodeling or building new barns to serve their needs more completely. To meet the requests for help in planning dairy barns and other shelter for dairy cattle in the north central region of the United States, this publication is being made available. It is based upon the best available information[1] although there is a difference of opinion on many points. Additional scientific research now under way or being planned may soon supply more complete information on housing requirements. See Figures 1 and 2.

There is more to be considered in planning the complete dairy building and equipment layout than just the barn itself. The size and location of the barn with relation to the whole farm—the fields, roads and lanes, drainage, prevailing winds and landscaping—are of importance and should be worked out before construction of any buildings is started. The storage of feed and bedding is a part of the plan. A milk house as a part of the dairy unit is necessary for handling and cooling the milk and cleaning the utensils. On farms where there is both dairy and beef production, barns may be arranged so that the number of cows milked from year to year can vary, depending upon the relation of meat and milk prices.

Locating the Dairy Housing Unit on the Farmstead

THE dairy barn should be a neat, well-kept building of pleasing proportions, but planned strictly for service. Such a barn properly located will show up well from the highway and from the farm house, as well as from the farm service yard. The milk house is best located on the clean, well-drained side of the barn, facing the dwelling and driveway, or barnyard service court. See Figure 4.

Of the many things to be considered when locating a dairy housing unit, the **farm house** will usually come first. It will, no doubt, already be a part of the established farmstead but in order to protect its place in the plan other buildings should be properly located. In general the farm house is given the more prominent location, nearest to, but a least 100 feet from

[1] Information on the functional requirements of dairy cattle housing in the United States is presented in the United States Department of Agriculture Circular #722, "Functional Requirements in Designing Dairy Barns" which was used freely in the preparation of this manuscript.

the highway, on the highest part of the building site, and arranged to take advantage of attractive views. It is well to separate the dwelling from the poultry and animal housing units and lots by a distance of at least 100 feet. It is suggested that the house be located to the north and west of the barn yard and service buildings.

The arrangement of the farmstead and the dairy unit will be determined by the direction and access from the highway but favorable views and exposure should control the building arrangement. In cold climates, a grove to the north and west will tend to keep out drifting snow and provide protection for the cattle yard, service yard and the buildings on the farmstead. Since lanes to pastures and fields are used daily during pasture season the barn is best located convenient to these lanes. Likewise the barn should be conveniently located for the delivery from the fields of crops that have to be stored; close to the service yard for the movement of milk or cream and livestock to market, and for the receiving of purchased feed and other supplies. Water to the barn, electric service, sidewalks and driveways are essential parts of the modern dairy housing unit. Some dairymen prefer to have the long way of a stanchion barn running

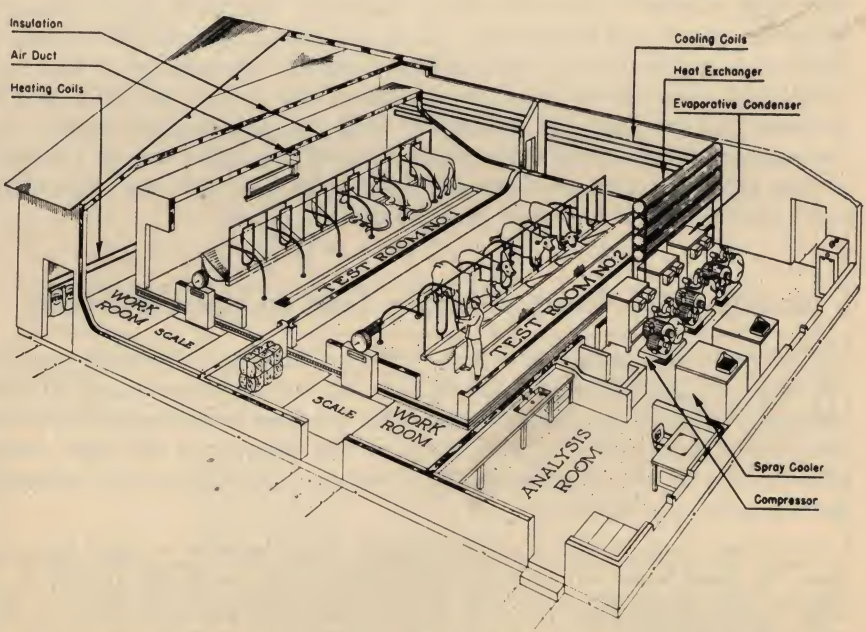


Fig. 2—Controlled laboratory conditions are to be used in finding new facts regarding the effect of temperature, humidity, light, air movement, space and other conditions upon the performance of the dairy cow.

This is the Animal Psychroenergetic Laboratory used in a cooperative research project by the University of Missouri and the United States Department of Agriculture.

north and south if their protected barn lot arrangement will work out this way, if grades will work out on sites that are rolling, if the service yard can be arranged to their satisfaction and if the barn will show up favorably from the highway and entrance drive. Other dairymen find the east and west barn fits their site better and that the south exposure gives good lighting and ventilation. In the loose housing system the barn may be located in either direction because the south or east exposure for the cattle yard will be satisfactory.

The topography of the site influences the layout of all buildings, and often affects the design of the buildings themselves. For instance, a basement barn located partly in a bank or hill is easy to construct with a driveway into the hay loft. In some areas dairymen like and use the driveway to the hay loft very effectively while in other areas it is not considered necessary. On a level site such a driveway would frequently cost more than it is worth, and there would be a large earth fill in the barn yard to work around. Topography will determine drainage which, if not naturally routed well around the barn, can be altered through grading to provide good drainage for barn, service yard and yards for livestock. Where drainage is poor due to a flat topography, and where soil is easily worked into mud, graveled or preferably paved lots will be most desirable. The concrete paving is best placed over a gravel fill on soils subject to frost heaving. To keep out surface water it is important to establish the finished grade for the floor at least 6″ above finished outside grade.

Saving Labor by Good Planning

THE dairy cow requires in the neighborhood of 150 man-hours of labor per year. Her labor requirement is higher than for any other farm animal. The cost of labor is second to the cost of feed in the annual cost of keeping a dairy cow.

Fig. 3—Comfort and lots of good feed are as essential in winter as in summer.

There is a wide range in the time requirements per cow on dairy farms. Some farmers either work faster, or have their barns planned and their work arranged to accomplish more in the same length of time than others. In Nicollet county, Minnesota, in 1943, one farmer with 21 cows averaged 90 man-hours per cow for the year, while another dairyman with the same number of cows worked 193 man-hours per cow. In one phase of this study, 33 pairs of herds of equal size and level of production were compared and the most efficient workers averaged 114 man-hours per cow, while the least efficient averaged 156 man-hours.

Many dairy barns are now being remodeled to reduce time and energy requirements as well as those being remodeled to meet sanitary regulations. It is not uncommon to get reports of farmers who have reduced their daily travel in doing winter dairy barn chores as much as two miles per day by

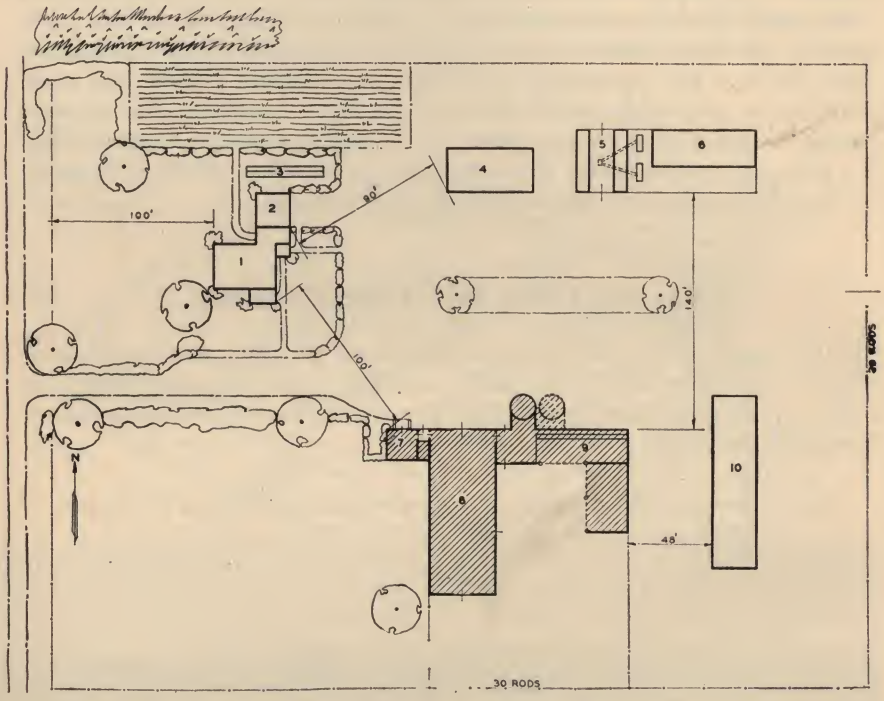


Fig. 4—Suggested farmstead layout on east side of the north–south road.

1. House
2. Garage
3. Clothesline
4. Poultry House
5. Corn Crib and Granary
6. Hog House
7. Milk House
8. Dairy Barn
9. Bedded Shed
10. Machinery Shed and Shop

Fig. 5—Large feed carts and double, self-swinging doors save time in doing chores.

changing their barn arrangements or plan of work. Nor is it unusual to get reports on labor savings of an hour or more per day through the addition of barn cleaners and other equipment. As a matter of fact, changes made to reduce time and labor will make additional time available for some of the more essential operations in producing clean milk, and in improving the dairy herd.

Labor saving—The first step in reducing chore time is careful and complete planning of the dairy cattle housing unit well in advance of construction. To be practical, the equipment selected must be reasonable in cost, easy to operate and show promise of long, trouble free service. Daily savings of time and energy due to a good plan and carefully selected equipment often add up to enough to have a very important effect upon the success of the dairy business. When mechanical power replaces energy, fatigue is reduced and when automatic controls replace manual controls the operator can free his mind of a lot of routine details. This all should add up to greater regularity, better care for livestock, more profitable production and actually more enjoyment in farming than one had ever expected. Perhaps one should be warned against increasing the size of operation to use up all he has saved under penalty of losing his new found freedom.

Grain and concentrate storage is a matter of varying importance, depending in part upon the quantity fed the dairy herd and other livestock. Where a large quantity of grain is produced, or purchased and fed, suitable storage some distance from the barn is advised in order to reduce the fire risk.

Fig. 6—Baled or chopped hay can be moved efficiently on low-cost trucks from ground level storage.

For the corn and grain farm, as well as for the dairy farm with a one story barn arrangement, a separate grain storage or grain and corn storage building is usually the most satisfactory. Like the dairy housing unit, the proper planning of this building, the planning and selection and arrangement of the equipment and the proper management of it all tends to save labor and increase farm income.

Where only small amounts of grain are produced, it is common practice to provide grain bins in a part of the hay loft. This plan usually works well, especially when there is a driveway into the hay loft. Grinding, seed cleaning and feed mixing can take place on the driveway floor. An efficient grinding and mixing arrangement can be worked out in the barn loft with elevated hopper bottom bins, elevator, grinder and mixer.

Ground and mixed feeds are usually stored for greatest convenience in feeding. A ton or more of ground feed may be moved into the barn storage by truck or wagon at one time. Concentrates require a dry, dust tight storage place and preferably not in the silo room. Since mixed feeds for young stock may be different from those for the dairy herd, two or more bins should be provided. It is also a good plan to include space for the concentrate feed cart in the feed room.

Silo size and location are important because this structure is designed to supply a large tonnage of high quality feed almost directly into the feed alley. If a feed cart is used, a generous feed room between the barn and silo will prove well worth the cost, and place the silo from 8 feet to 10 feet from the barn. This will allow good ventilation and lighting. In the northern zones, locating the silo where the sun can shine on it, will result in

frozen silage thawing free of the walls at least once every few days throughout the winter. However, a silo on the south side of the barn will reduce the light in the barn. When erected at the end of the barn, it eliminates the chance for a future extension to the barn on that end. As a result, the silo usually gets located on the north side of an east-west barn, or to the west side of a north-south barn.

Two silos of small diameter, while costing more than one large silo, permit greater flexibility in the rate of feeding and size of herd. By feeding a greater depth of silage each day there will be less waste, especially when the weather is warm and at times when the herd may be small.

Space requirements: In addition to the space actually required for housing the dairy cow it is necessary to include milk house facilities, feed and bedding storage and housing for calves and young stock. Young stock, dry cows and heifers may be housed in a shed or less expensive building so long as it is conveniently located for care and feeding. The farmstead plan in Fig. 4 has a convenient arrangement of sheds and protected barn lot for this purpose.

Table I gives the weight and space requirement per ton of various roughages and concentrates fed to dairy cattle as well as bedding materials. The approximate amounts of each required per day and per season for a

Table I—Hay and Bedding Storage Space Requirements

Material	Wt. per Cu. Ft.	Cu. Ft./Ton
Hay—Loose in Shallow Mows	4 —pounds	512
Hay—Loose in Deep Mows	4.5+pounds	444
Hay—Baled Loose	15 +pounds	133
Hay—Baled Tight	20 pounds	100
Hay—Chopped Long Cut	8 pounds	250
Hay—Chopped Short Cut	12 pounds	167
Straw—Loose	4 —pounds	512
Straw—Baled	12 pounds	167
Shavings—Baled	20 pounds	100
Silage—Shallow Silos up to 30′	40 pounds	50
Silage—High Silos over 30′	50 pounds	40
Concentrates	45 pounds	45
Small Grain	Use 4/5 of bu. wt.	

In computing storage space for feed and bedding, Table I may be used. For example, one ton of loose baled hay required 133 cubic feet of storage space, and if piled 10 feet deep the floor load would be 15 pounds per cubic foot times 10 feet or 150 pounds per square foot.

cow in each zone are given in tables IIA, IIB and IIC. With this information, one can easily determine the practical herd size for his farm after he has estimated his crop yields. The weights are also handy when computing loads on hay mow joists.

Tables IIa, b and c may be used to compute the amount of hay, silage, concentrates and bedding per cow or per herd in any zone in the region. When the total amount is known, one can check against the feed supplies available to make certain that the herd size is in balance with the probable feed supply. The size of hay mow may also be more accurately determined for the different types of hay when the needs and the supply have been determined.

Table II-a—Hay Requirements for Dairy Cattle in Pounds

One cow (1000 lbs. wgt.)	If Hay Is Only Roughage Fed			If Both Silage and Hay Are Fed		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
	210 da.	175 da.	140 da.	210 da.	175 da.	140 da.
Daily	25 lbs.	25 lbs.	25 lbs.	15 lbs.	15 lbs.	15 lbs.
Season	5250 lbs.	4375 lbs.	3500 lbs.	3150 lbs.	2625 lbs.	2100 lbs.
Storage Loose in cu. ft.	1167	972	875	700	582	525

Table II-b—Silage Requirements for Dairy Cattle in Pounds

One cow (1000 lbs. wgt.)	If Both Hay and Silage Are Fed			If Silage Is Chief Roughage Fed*		
	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
	210 da.	175 da.	140 da.	210 da.	175 da.	140 da.
Daily	30 lbs.	30 lbs.	30 lbs.	60 lbs.	60 lbs.	60 lbs.
Season	6300 lbs.	5250 lbs.	4200 lbs.	12600 lbs.	10500 lbs.	8400 lbs.
Storage in Cu. Ft. at 45 lbs.	140	117	93	280	233	187

*It is intended that some good quality dry hay will be fed with this heavier feeding of silage.

Running water is a part of the dairy unit. It is essential in a modern dairy barn that there be water under pressure flowing to automatic water cups in the stanchion barn; to float controlled tanks in the pen barn, barn lots and pasture; to the milk house for cleaning, washing and cooling; to fire hydrants; and to convenient outlets in the barn for cleaning and washing as required. There are certain requirements for a successful water system. First, there must be an adequate safe water supply for the entire

Fig. 7—Manure removal is easier and takes less time if manure is loaded directly on a spreader. The next step is the mechanical barn cleaner which eliminates drudgery.

Table II-c—Bedding and Concentrates Requirements for Dairy Cattle in Pounds

One cow (1000 lbs. wgt.)	Concentrates		Bedding					
			Stanchion			Loose Stabling		
	300 lbs. Butter Fat or 7500 lbs. Milk	400 lbs. Butter Fat or 10000 lbs. Milk	Zone 1	Zone 2	Zone 3	Zone 1	Zone 2	Zone 3
Daily			6 lbs.	6 lbs.	6 lbs	12 lbs.	12 lbs.	12 lbs.
Season	2000–2500 lbs.	2500–3000 lbs.	1260	1050	840	2520	2100	1680
Storage in Cu. Ft.	55	70	315	263	210	630	525	420

It is suggested that feed and bedding requirements for young stock be computed on an estimated weight basis taking 1000 lbs. live weight as equal to one 1000 lb. cow. Provide additional feed and bedding storage space of at least 25% for good crop seasons to allow for summer feeding and to permit some carryover.

The amounts of daily feed and bedding used in these tables are only approximate and may be adjusted for heavy feeding or to meet other specific requirements.

farmstead. Second, there must be a satisfactory pump and frostproof piping system so installed as to be safe from weather or other possible causes of trouble. Third, a system can be expected to give good service only when properly cared for, protected from freezing, and repaired as required.

The water system is a great convenience for cooling milk and washing milking utensils. However, in either operation there is water to waste. A 4-inch drain to a large settling or septic tank and disposal by a dry well or a tile system laid in gravel bedded trenches are often used. Drainage from the septic tank by tile line to isolated ravines is sometimes suitable and possible. For convenience and economy, water from the cooling tank is often used for stock watering.

Fig. 8—Paved barn lots and loose housing barns may be quickly cleaned with a mechanical loader. This barn lot is now paved.

The Stanchion Barn

THE STANCHION barn offers a highly specialized housing system for the dairy cow. Its planning and operation are in part regulated by the milk codes in effect in most fluid-milk producing areas. New developments in methods, arrangement and equipment tend to save time and labor, increase the efficiency of the cow and improve the quality of the milk. The success of the stanchion barn largely depends upon the thorough planning of the barn and related structures, its location on the farmstead and the way it is managed when in operation. Just as with a new barn, complete planning before starting any remodeling will eliminate mistakes and keep costs down. Only in this way can existing buildings be put to best use.

Types of Stanchion Barns

TWO GENERAL types are in common use throughout the region. Perhaps the most common type, especially in the northern zones, is the two story barn with feed and bedding storage over the livestock. The one story barn, more frequently found in the southern zones, is being looked upon with increasing favor throughout the entire region for a number of very good advantages. Both types of barns are presented on the following pages.

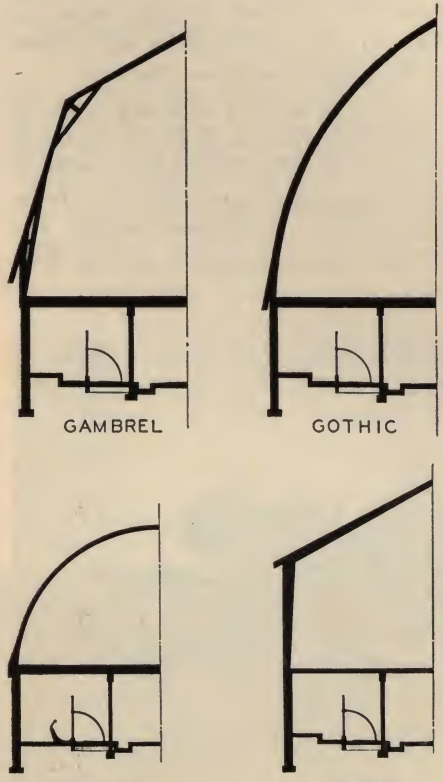


Fig. 9—Four standard types of barn frames for two story barns. Masonry walls often extend to hay mow floor joist level. Capacity of loft can be adjusted to storage needs by selecting suitable height of mow. When changing from loose hay to baled or chopped hay, care must be taken if floor joist and girders are not to be overloaded.

The Two-Story Barn. This must have a frame strong enough to carry the weight of a winter supply of hay, grain and bedding for the herd, as well as loads imposed by wind and snow. Many variations are possible in detailed arrangements but basic design and dimensions have become almost standard.

Storing hay, grain and bedding above the dairy herd has many advantages. Here hay and bedding are placed where they can be used by simply throwing them down conveniently located chutes into the feed and litter alleys below. By building the two-story structure, only one foundation and one roof are required. Economies in building costs and labor of operation are thus secured which are hard to obtain in one-story construction. Furthermore, in many areas, the two-story barn can be built today at a relatively low cost because local builders are more familiar with construction. See Figure 9 for different types of two-story barn framing.

The fire hazards of two-story barns are a serious problem. Fire in the hay loft of a barn can seldom be brought under control or put out. While insurance can be carried on the barn, feed and livestock, the work of years of breeding and the loss of income from the dairy enterprise, until a new barn can be built, can be a serious loss.

To overcome this hazard, at least in part, the reinforced concrete mow floor has been successfully used. Recently mow floor construction of masonry units of various types has been developed. Where there is a fireproof mow floor, self closing doors in the hay chutes and stairway to the hay mow are essential to protect the contents of the first floor in case of fire. A fireproof covering of cement asbestos board over a wood frame loft floor, with fire safe doors on chutes and mow stairs, should increase the time one would have to remove animals and equipment in a fire in the barn of wood construction. This type of construction for fire safety may be too expensive under some conditions but is desirable when economically practical.

Advantages of the two-story barn:

1. Economical to build because of one roof and one foundation and standard construction. Comparable cost figures will answer the question of which can be built for the lowest price.
2. Convenient to work in because all is under one roof with feed moving by gravity from second to first floor.
3. Dairy workers are used to the method of herd management in a two-story barn. Likewise, tenants may prefer two-story barns if that is what they are used to.
4. More compact with reference to space required and therefore easier to arrange with cattle yard on one side and service yard on the opposite side.

The One-Story Barn. Present day trends indicates a growing interest in one-story barns, due in part to the growing use of baled or chopped hay or grass silage. Those who have this type of dairy unit find that it works out to their satisfaction when it has been well planned, and when the layout is complete. Frequently the old barn can be used for housing the young stock, dry cows, roughage and bedding. In this case a new, modern dairy barn of one-story construction may cost little more than remodeling the old barn.

Such a development may thus provide better and more generous housing at relatively low cost.

Two types of one-story barn framing, as shown in Figures 10 and 11 include the flat-roofed barn. This is built much the same as a first story of the conventional two-story barn. In fact, a hay loft can be built on it at any time if the joists and girders are of adequate size. If the walls are masonry, it can be made highly fire resistant by using a fire-proof ceiling material and mineral insulation between the joists. [A good covering of gravel on the roof of a built up tar and gravel roof, will help protect the barn from fire on the outside.] Metal window frames and reinforced glass on sides facing other nearby buildings will add to the fire resistance. See Fig. 10.

The framing section in Figure 11 is a simple gable roof. Some will prefer the roof truss to be self supporting, that is, with no columns, even at some added cost. This barn with wood or steel frame is practical while masonry walls with roof trusses of wood or steel will prove low in cost, attractive and easy to build.

When the walls, roof, eaves, gable ends and ceiling are of fire resistant construction and no feed or bedding is stored in the barn, the fire hazard and danger to persons removing livestock during a fire should be small.

It is best to locate the storage building for hay and bedding at a safe distance from the fire resistant, one-story barn, and to provide self-closing fire doors in the passageways between the barn and hay storage. Another plan is to locate the hay and bedding near the barn and to protect the barn by providing a fire wall and self closing fire doors between the livestock barn and the hay storage barn.

Owners of one-story barns claim the following advantages.

1. Reduced fire risk to herd and milk income.
2. Reduced windstorm hazard.

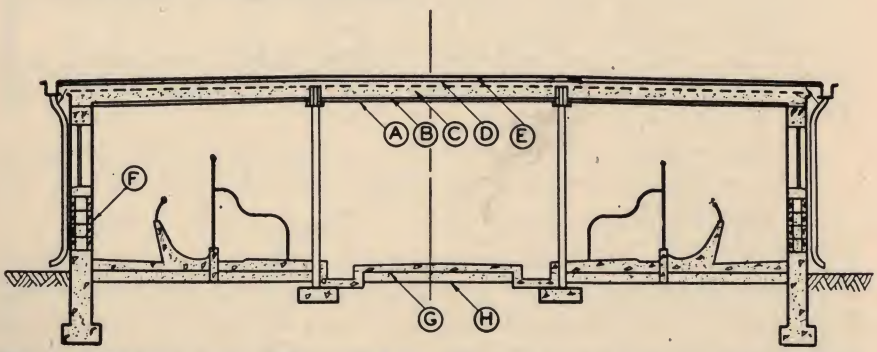


Fig. 10—One story barn of flat roof design. Fire resistive construction, insulated and ventilated for moisture control, this section is easy to build. Key: A—Ceiling material of rigid board or 1″ wood; B—Moisture vapor barrier; C—Mineral insulation; D—Air passage from one side to other under roof; E—Roof deck and built up roofing; F—Masonry walls with suitable insulation; G—Moisture barrier; H—Gravel fill.

3. Easier to move chopped or baled hay and even loose hay along a concrete walk on rubber tired, roller bearing carts than feed it down hay chutes.
4. Dairy unit can be built a part at a time, thus the initial construction cost of a complete unit is spread over a number of years.
5. Easier to build than barns of two story construction.
6. Easier to repair, paint, re-roof and maintain.

The Stanchion Barn Plan

FOR GREATEST convenience in managing and operating the dairy barn, the plan is of first importance. See Figure 12 for barn arrangements; use the following suggestions as guides.

Stanchions: Locate the stanchion section at one end of the barn with pens and hospital stalls at the far end. See Figure 12. Dairy cows may then be separated from the young stock with a partition, should this become necessary or desirable.

Stalls: For width and length of stalls, see Table III and select the proper size for the herd to be housed. By adjusting the litter alley about 4 inches off the center of the barn at one end of the stanchion section, one can get an 8″ difference in stall lengths and not change feed alley widths. See Figure 15. When stall lengths are different in a barn there may well be some changes in stall width. If stall widths are to be varied, make short stalls 3′—6″ wide, medium stalls 4′—0″ wide and a few longer stalls 4′—4″ wide. Note that from 4 inches to 6 inches longer stalls can be used when an

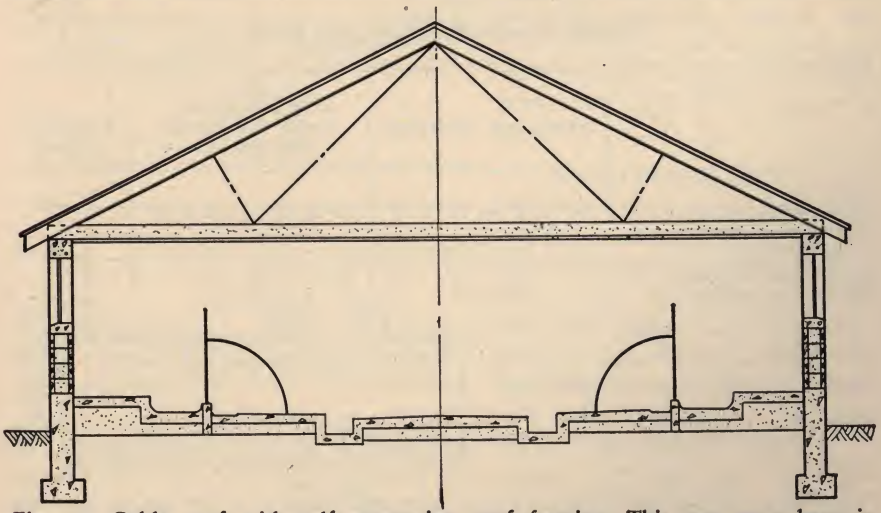


Fig. 11—Gable roof with self supporting roof framing. This one story barn is moderate in cost, easy to build and may be free of columns. It will also be a safer fire risk if built and insulated with non combustible materials.

electric fence operated, coat hanger shaped wire is hung over each cow just above and back of her shoulders and adjusted to proper height. This so called "cow trainer" causes her to step back when she uses the gutter.

Table III—Dimensions for Cow Stalls

Weight of Cow	Girth in Inches (1)	Width of Stall	Stall Length (2)	
			Standard Stall	Cow Trainer Stall
800 #	65"	3'–4"	4'–6"	4'–8"
1000 #	70½"	3'–8"	4'–8"	5'–0"
1200 #	75"	4'–0"	5'–0"	5'–4"
1400 #	79½"	4'–4"	5'–4"	5'–8"
1600 #	84+"	4'–8"	5'–8"	6'–0"

(1) Girth measured in inches around cow, taken to the rear of shoulders.
(2) Length of platform is measured from rear of stanchion curb to edge of gutter. For tie stalls increase 6 inches.

Pens: To determine the number and pen sizes, see Table IV and select pens as needed. The larger pens are obtained by locating them in the corners of the bedded area.

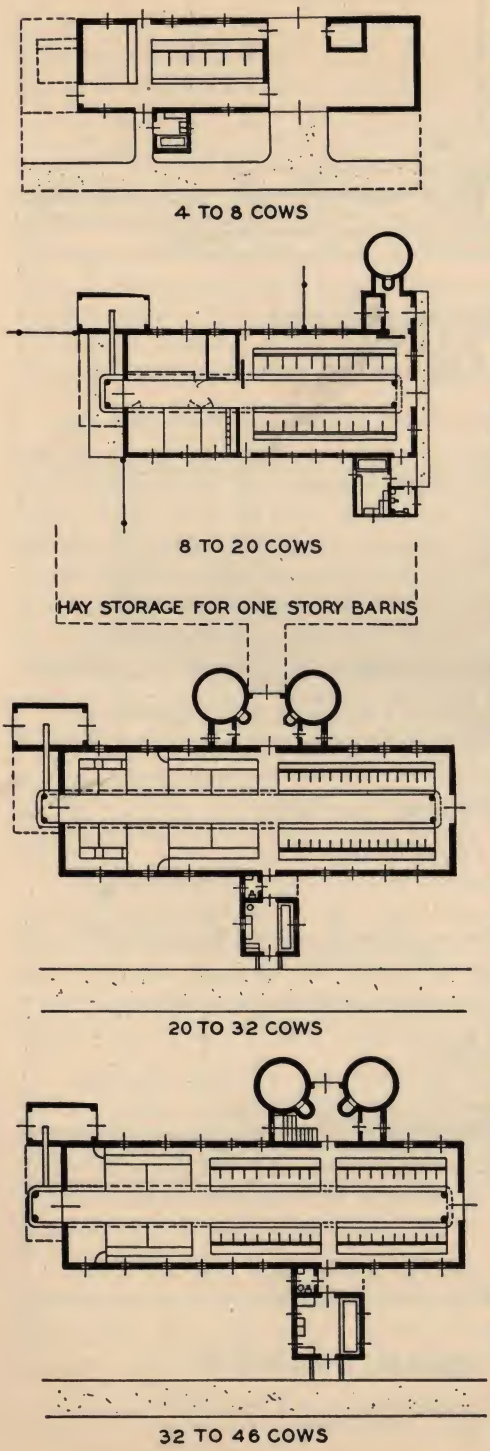
Floor sections: Face-out arrangement is most efficient. Figure 13 shows typical arrangement with the high back and sweep-in manger optional. Face-in arrangement, Figure 13, works for either type of manger.

Table IV—Dimensions for Pens

	Jersey and Guernsey	Holstein, Brown Swiss, Shorthorn and Ayrshire	Partition heights
Bull pens	10′ x 12′ to 12′ x 12′	12′ x 12′ to 12′ x 14′	5′–3″
Cow pens (Test or maternity)	10′ x 10′ to 10′ x 12′	10′ x 10′ to 12′ x 12′	4′–6″
Individual calf pens	4′ x 6′	6′ x 6′	3′–9″
Calf pens for four	10′ x 10′	10′ x 12′	4′–6″

For a number of calves in one pen allow 20 square feet per calf, and 20" to 25" per calf for stanchion and manger space.

Manger dimensions: Manger dimensions are given for both types. The high back type may have sanitary advantages if properly used. Be sure to provide a substantial drain for each manger leading to the gutter by way of the cross alleys or by tile drain under a cow stall to the gutter. Gutter dimensions meet code requirements and are standard for barn cleaners.

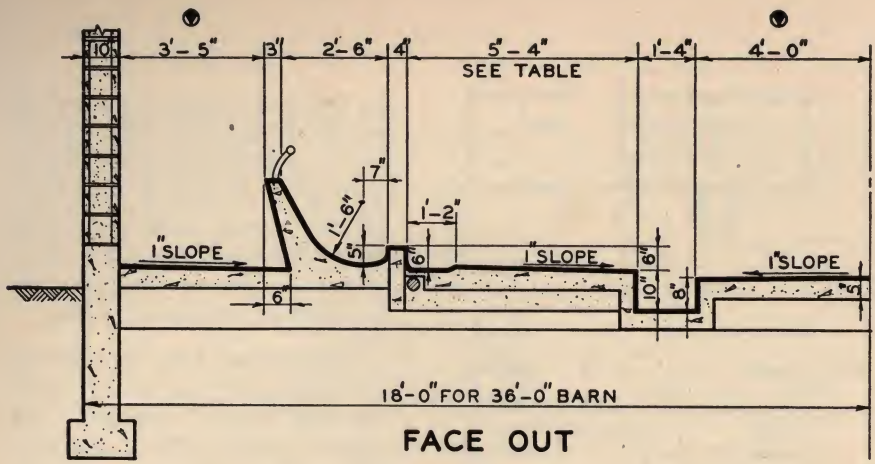


See Figure 13. Extend gutters full length of barn and make necessary arrangements for barn cleaner installation if one is to be installed. Gutters inside pens make them larger and easy to clean. Covers for gutters through pens are made in removable sections.

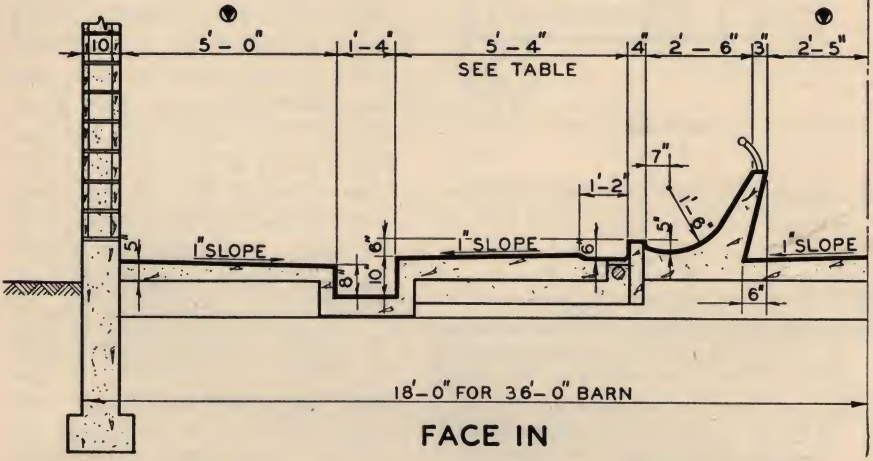
Feed alley: Feed alley width is adequate for the use of standard feed carts if mangers have corners rounded off at cross alleys and if cross alleys are at least 4 feet wide. For the shortest chore route, a bank of two rows of cows with a cross alley at each end saves steps but two cross alleys reduce cow capacity. For the larger herds of over 30 cows, two such sections may be provided with the milk house located off the center cross alley. See Figure 12. Feed alleys with high back mangers have level floors which are easiest to move loaded carts in. Where barn widths are limited, the sweep-in manger and feed alley can be narrowed up without crowding, better than when the high back manger is used.

Floors: Provide floors of sanitary, impervious material throughout the stanchion barn. Concrete is acceptable if properly placed with slope for drainage of stalls and litter alley; trowel finish for mangers, feed alley and gutter bottoms; float and broom finish for pens, cow stalls and litter

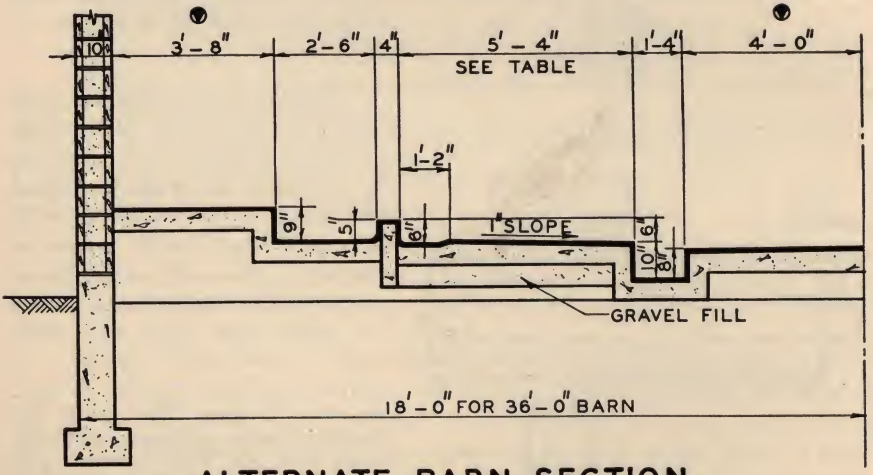
Fig. 12—Typical floor plans for stanchion barns complete with milk house, silos and manure cleaner provisions that are adaptable to either one story or two story barns. All are arranged so as to permit future expansion.



FACE OUT



FACE IN



ALTERNATE BARN SECTION

● ADJUST DIMENSIONS TO FIT VARIATION IN STALL LENGTH AND BARN WALL THICKNESS.

Fig. 13.

alleys and any cross alleys used by the cows. Provide at least a 4-inch concrete floor over a 4-inch sand or gravel fill for best results. Use a good mix for strong, durable concrete. Insulating concrete in the platform under the cow can be made of mineral insulation materials and topped with an inch or two of good concrete. Just how effective this insulated stall floor is, one cannot tell. Barn floor temperatures are usually about the same average temperatures as the barn air. In a well bedded stall there is little temperature difference between an insulated stall floor and a sand and gravel concrete floor. A well bedded stall is much more comfortable than one which is not so well bedded. The longer stall used with the cow trainer permits the cow to lie down forward of the gutter a few inches where there is likely to be more bedding than along the very edge of the gutter.

Barn width: Barn widths as shown in Figures 12 and 13 are 36 feet. A driveway barn should have a 36 foot width. However, where a barn cleaner is used in the face out barn and the local milk inspection permits, the litter alley may be reduced from 8 to 6 feet and the barn width would then be 34 feet. In remodeling narrow barns, further savings in width can be obtained by narrowing litter alley, feed alley and sweep-in manger. For herds of 10 to 12 cows and over it is well to keep the feed alley wide enough for a feed cart. A barn less than 30 feet wide would have to be increased in width or silage would have to be carried in a basket.

Barn length: The length of the barn will be determined by the number and width of cow stalls, the number and width of cross alleys and the number and size of pens on each side of the barn. Add to this, any space needed for horse stalls, feed rooms, barn cleaner, elevator or other necessary and related space. See the barn plans, Figure 12, for suggested arrangements.

Ceiling height: Provide 8′—6″ between litter alley floor and ceiling to meet the requirements for 500 cubic feet of space per cow where the under side of the joist is sealed off. Where the space beneath the joist is not to be sealed off, the floor to the underside of joist distance may be reduced to 8′—0″, especially in northern zones. In southern zones, a greater ceiling height helps keep the barn cool in hot weather.

Daylight: Window glass area required per cow is at least 4 square feet with 3 square feet in northern areas being acceptable. For glass block in place of windows, provide 6 square feet of glass area per cow because of lower efficiency in light transmission. Provide adequate window space that can be opened for air in hot weather. Storm windows are required as indicated in section under Insulation, Table V.

Artificial light and electric wiring: Provide at least one light outlet for each 12 to 16 lineal feet of litter alley and the same for each feed alley. Place litter alley lights on a separate circuit with switch controls at doors for cow entrance and door to milk house. Place switch control for feed

Table V—Construction of Windows and Doors

For warm barns where heat must be conserved to allow for adequate ventilation in cold weather, the following construction will be desirable.

Zone	Sq. Ft. Glass	Storm Windows	Doors Insulated	Storm Doors
1—North	3	Yes	Yes	Yes
—South	4	Yes	Yes	Yes
2—North	4	North & West	Yes	No
—South	4	North & West	Yes	No
3—	4	No	No	No

alley light circuit near feed room. Provide one light outlet for each two pens with switch along side the pens in litter alley. Other lighting for milk house, passageway, feed room, silos, hay loft, cattle yard and service yard are essential for efficient working conditions at chore time throughout about one half of the year. Electricity is provided for convenience. The lighting will only be useful if the switches are conveniently located for control of the light.

While the lighting is being planned, it is important to see that adequate service is extended to the barn, both for lighting and for power use. It is most convenient to have a dead front, grounded entrance switch for both 230 volt circuits and 115 volt circuits all properly fused in the same entrance switch box. Power outlets will be required in the milk house for automatic hot water heating by electricity or oil burner, milk cooling if mechanical system is used, water system, milking machine, barn cleaner, cow trainer, silo unloader, ventilating fans and a system of well located outlets for the use of portable tools and equipment such as clippers, drills, heat lamps and the like.

The way to save labor by using electricity is to plan for and to use this low cost energy wherever it will pay to use it. At present rates for labor and electricity, energy from the electric service has better than a 100 to 1 advantage over hand labor. The only difficulty is that to use it efficiently, we must have efficient, low cost, practical equipment that will have a long, trouble free service life.

Interior finish: Whitewash each year or otherwise paint or finish interior of barn walls and ceiling white, and wash or repaint once each year. Good lighting requires good reflection from all exposed parts, and white or very light colored paint or whitewash will serve this purpose. Where walls are painted it is suggested that the lower four feet of wall be painted a darker color as this will be more serviceable.

Walls: Provide walls with insulation values according to Table VI, and instructions given in the section on insulation. Barn walls should have a

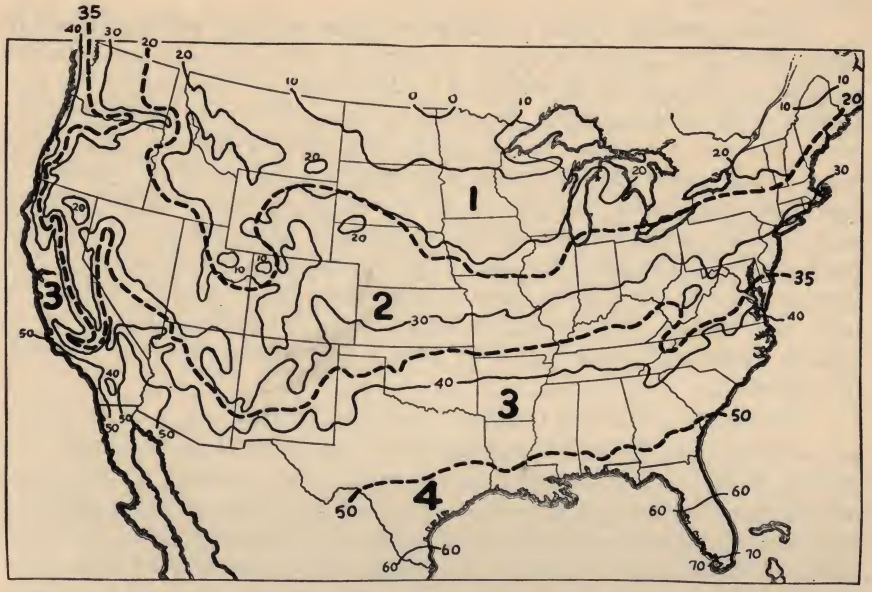


Fig. 14—To allow for climatic variations within the region, the above zone map is used for reference throughout this publication. (Courtesy of U. S. Department of Agriculture)

smooth, sanitary interior finish, capable of withstanding the impact of livestock, the load of feed stored above as well as the tipping effect of high winds. Masonry walls in particular, require adequate footing placed at proper depths. See Figure 13. For laying up masonry units in barn walls, use portland cement and lime mortar rather than gypsum because of the moisture that is ever present in any animal shelter that is closed in the winter. Condensation in walls can be controlled by using a moisture barrier at or near the warm side of the wall as described in the section on Vapor proofing.

Table VI—Insulating Values for Walls and Ceiling

Desirable insulating values (a measure of the resistance of a material or wall to the flow of heat) for walls of warm barns are given. When the location of a farm by zone has been determined this table will specify the insulating value of walls and ceilings. This insulating value may then be used in connection with Table VII and Table VIII to aid in selecting a suitable wall and ceiling.

Barn Size	Zone 1		Zone 2		Zone 3	
	Walls	Ceiling	Walls	Ceiling	Walls	Ceiling
Large	4.0	8	3.0	6.0	2.0	3.5
Small	6.0	10	4.0	8.0	2.0	3.5

Vapor proofing: Vapor proofing the inner wall and ceiling surface of warm dairy barns in such a way as to eliminate difficulty from condensation or moisture damage in the walls and in the hay loft is essential for the protection of the building itself. Moisture in walls reduces the effectiveness of insulation and provides a decay hazard. Moisture in masonry that is not especially designed for use under high moisture and freezing temperature conditions may mean that the years of service of such masonry will be reduced. Tile walls, concrete blocks or masonry units, when laid up with poor quality mortar have resulted in costly failures in basement barns. The more severe the climate the more critical becomes the quality of masonry units and mortar. High strength, load bearing masonry units laid up in cement mortar will prove best if the wall is properly selected for its insulation value.

Whether the walls and ceiling are of wood, or masonry, a vapor barrier on the interior of the wall consisting of (a) sealed metal sheets or (b) spar varnish or (c) aluminum pigment paint or (d) shiny, asphalt saturated and coated, black building paper will be needed. This moisture barrier must be applied to or built into the side of the wall and ceiling exposed to the warm moist air. Inside vapor barriers in the warm, moist barns must be tight to be effective, while outside ventilation of the wall space is necessary to remove any moisture that does get past the barrier.

Some breathing of the wall to the exterior will help because cold air entering the wall under wind pressure or when barometric pressures increase, will warm up and take on a load of moisture if such is present in the wall. Then as the warm air leaves the wall space it will take with it the moisture it carries.

Hay lofts often become wet when hay chute doors are left open in cold weather. This is a serious hazard to the framework of the barn, for it provides ideal conditions for decay and rot, as well as weakening glued joints if the rafters are glued. Tight hay chute doors, closed when not in use, and roof ventilators will help. Wide siding boards with spaces between them will allow air circulation and still not permit enough rain to enter to cause damage. Where the siding is tight, ventilators at the ridge or large, protected openings high in each gable end will help to keep the hay loft dry. It pays to protect all parts of the barn from moisture and to do this one must plan for moisture control and build it in when the new barn is constructed or when the old barn is remodeled.

Insulation: A favorable heat balance which permits ventilation in all but the most severe weather is desirable in all zones. See Figure 14. With construction having reasonable insulation values it is possible to prevent severe and rapid temperature variations. With good ventilation and insulation, moisture condensation on the walls of the barn will be practically eliminated. In areas where high winds prevail and windbreaks are not available, there is a rapid movement of air though the walls of even the tightest

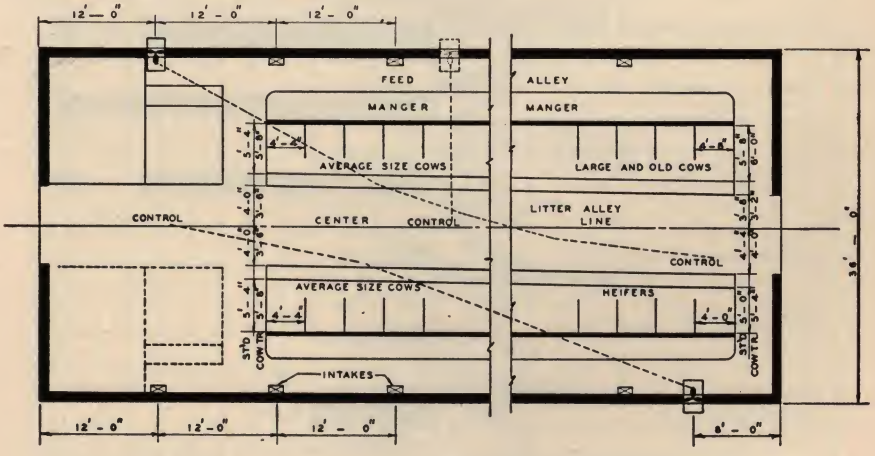
barn. This calls for even more insulation if the barn is to be kept at least well above freezing at all times.

For the insulation needs in each zone, see Table V for the storm window and storm door schedule and Table VI for wall and ceiling requirements. The final selection of wall, ceiling and roof construction may be made with the aid of Tables VII and VIII.

It should be added here that well ventilated barns have less moisture problems and, when insulated, the walls, ceiling and floors surfaces, have little or no condensation of moisture. It is, of course, also necessary to have the barn filled with livestock and the ventilation system in use at all times.

The mow floor of the two-story barn requires special attention in the construction to control condensation either above or on the under side, which is the ceiling above the cows. A double board wood floor with a vapor barrier paper between is satisfactory if hay or bedding is spread over the entire floor area throughout the cold weather.

Where a mow floor is placed on the top side of the joist, and a smooth ceiling is desired below, a lining of wood, sheet metal, plywood, or composition board may be applied over a vapor barrier on the under side of the joist at any time. When this is done, it is necessary to block off all air movement into the joist space along the outside walls. Where there is no covering of hay or straw over the mow floor, the space between joists, under driveways, alleyways and grain bins must be insulated if ceiling condensation is to be avoided at all times throughout the winter.



MECHANICAL VENTILATION SYSTEM

FANS — CONTROLS — FRESH AIR INTAKES

Fig. 15—Variable stall lengths and widths are worthwhile. Notice how the gutters deviate from the center line of the barn so minimum width feed alleys are the same throughout. Dimensions are given for barns with standard stalls and for barns equipped with cow trainers. Mechanical barn ventilation can be planned according to this layout. (See text for details)

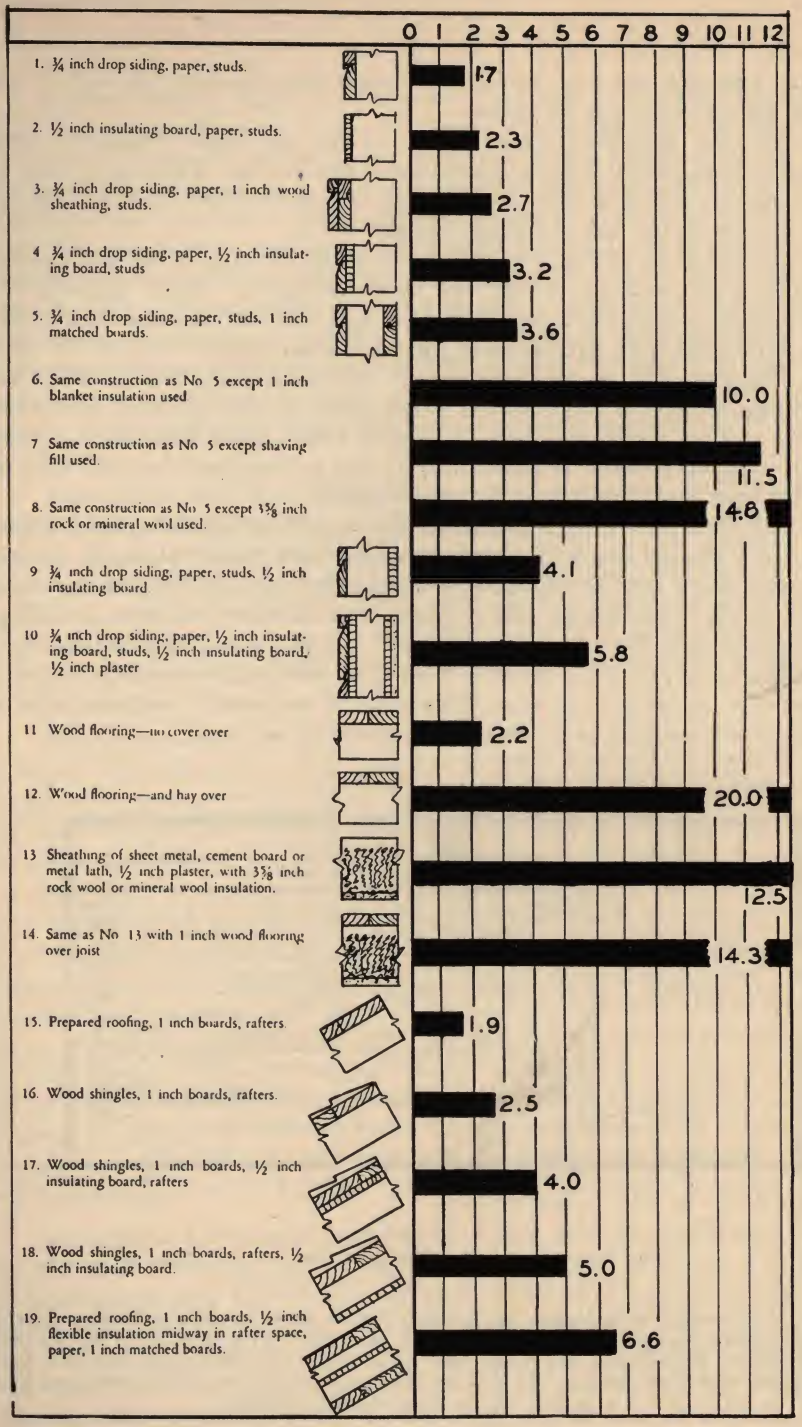


Fig. 16—Moisture barriers are also important in planning a wall, floor or ceiling. (See text for details)

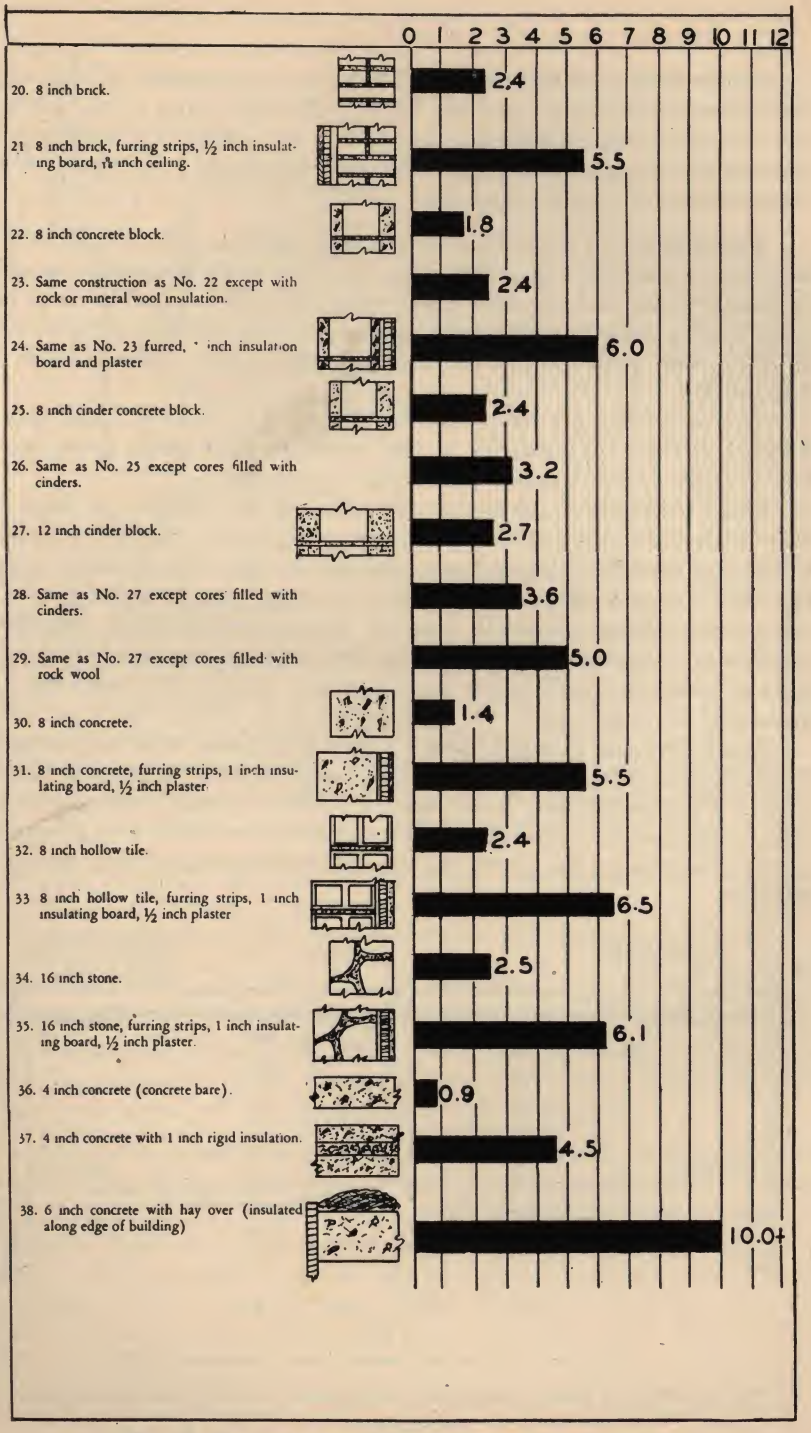


Fig. 17—See note on moisture barriers under Figure 16.

In one-story stanchion barns, fill insulation is required in the ceiling, the thickness depending upon the climate. This insulation is best protected by a moisture vapor barrier as described in the section on Condensation. Thorough ventilation of the space above the insulation is necessary to keep the insulation and the framing dry.

Ventilation: For many dairymen, one of the most serious problems has been barn ventilation. In addition to increased milk production, and better health of animals through good ventilation, it is possible to produce better quality milk in well ventilated barns which are free of barn odors. In barns with poor ventilation, one can often find rotting timbers and framework.

This section on ventilation and the foregoing sections on insulation and moisture control apply mainly to the stanchion barn which must be kept well ventilated, reasonably warm and free of drafts.

Good ventilation may be considered as six air changes per hour. For barns with 500 cubic feet of air volume per cow, the required number of air changes would be obtained by removing 50 cubic feet of air per minute. For mild winter weather, this could be increased to 100 cubic feet of air change per minute. This will tend to prevent sudden high temperature peaks on mild, sunny days. By knowing the number of cows and 1000 pound units of other livestock in the barn, one can quickly determine the total amount of air to be moved.

Studies indicate that good production is obtained in stanchion barns at a temperature of about 50° according to the work of Kelly & Rupel at Genesee Depot, Wisconsin. While cows produce well in warmly constructed, ventilated and insulated barns at temperatures down to 40°, it is a known fact that sudden changes in poorly constructed stanchion barns cut production sharply.

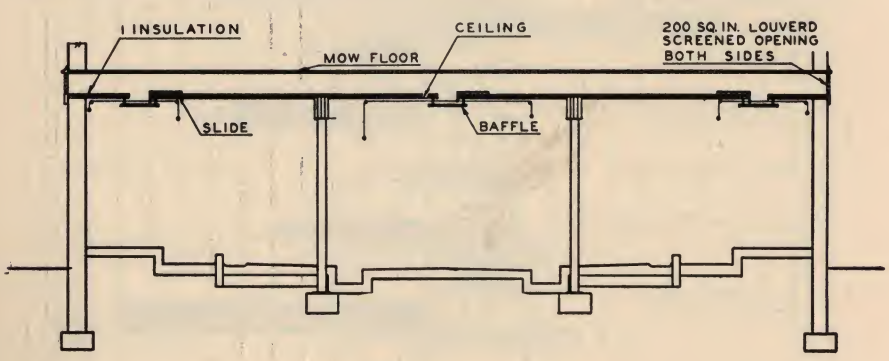


Fig. 18—Built-in intakes. Insulation is important on the under side of duct.

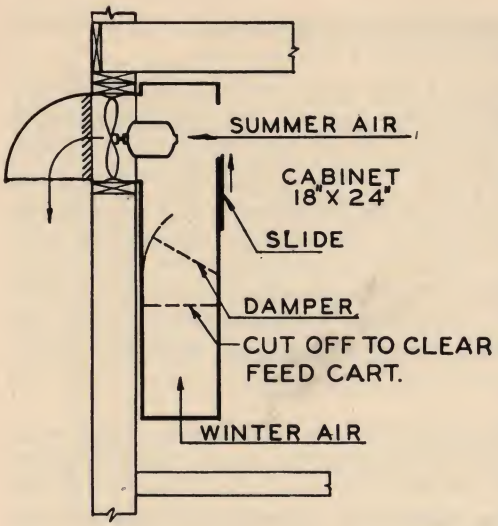


Fig. 19—Installation of an exhaust fan.

Mechanical ventilation where air is removed from the barn by means of an electrically operated fan, provides a low cost, practical system of dairy barn ventilation.

In planning the ventilating system it should be understood that heat is removed from the barn along with the warm, moist air. Barns that are cold, especially those that are difficult to keep above freezing temperatures if ventilated, will need insulation and perhaps storm windows to reduce heat losses. See the section on Insulation. In case of extreme cold when barn temperatures drop, the automatic controls will shut off the fans at any setting one may wish to make. As a general rule, it is a good plan to allow inside barn temperatures to drop to lower levels as cold winter weather sets in. This will allow fans to operate to lower temperatures before being shut off. Since barn ventilation is desirable at all times one should eventually plan to make the barn warm enough to permit ventilation in the coldest weather.

Select a fan or fans with capacity at 3/8" static water pressure sufficient to meet the ventilation requirements listed above of 100 cubic feet of air per minute, per cow or other livestock unit of 1000 pounds. A two speed fan is best as the fans will operate more of the time on low speed in cold weather. These fans should be designed for heavy duty, continuous service, barn ventilation purposes. Motors should be protected with overload switches so a fan frozen rigid with ice will not result in one being burned out. To control fan noise, the speed of the 16" fan should not exceed 1740 r.p.m. and a 21" fan should not exceed 1140 r.p.m.

Set the fan to exhaust through the wall of the barn at or near the ceiling height and provide a cabinet or duct so air may be taken from near the floor in cold weather and direct from the ceiling in warm weather. See Figure 19. Locate a single fan near the cold end of the barn and preferably where it will not have to operate against prevailing winds. See position 1 in Figure 15. For a two fan installation, place a second fan at the other end of the barn as in position 2 in Figure 15. Note automatic fan control units at opposite ends of the barns from the fans they operate as this arrangement tends to level off temperature and humidity differences. Where

three or more fans are needed, an additional fan control unit may be located near the center of the barn as shown as fan 3 in Figure 15.

Intakes of fresh air are needed if the fans are to move the air they should at reasonable static pressures and if fresh air entrance is to be properly distributed. Where calves and young stock are closed off from the section housing the dairy cows, a fan installed in the wall between the two sections will take warm air from the stanchion barn and force it into the section housing the calves. This will tend to warm and dry the calf barn.

One intake of 60 square inches is needed for each three cows or animal units. These may be commercial, anti-backdraft type intakes or they may be insulated ducts running crosswise of the barn between mow floor joists. See Figure 18.

Barn lot: A clean, paved, well drained barn lot is essential to keep cows out of manure and mud. See the section on Barn Lots under Loose Housing.

Milking Parlors for Stanchion Barns. The advantages of the milking parlor with elevated stalls will offer the dairyman with a larger herd, an easier and better way of milking his cows. Where each cow's milk must be carried to the milk house for straining, the chore travel increases faster than the size of the herd because of the greater distance. Why not let the cows carry the milk? Where there are two men available for chores it would be possible for one man to milk mornings and the other to milk evenings. While it would take one man longer to feed, clean and milk a large herd, he could still do it rapidly if he had a convenient milking parlor, holding area and labor saving equipment.

Another arrangement is to have one man feeding, grooming, letting out and stanchioning cows as they are released for, and return from their trip to the milking parlor. In some dairy barns, cows actually travel unattended to the door into the milking parlor. After being milked they return to their stanchions again without being driven. The other man would be milking in the milking parlor. If he has 4 stalls and a pipe line to carry milk direct from the cows to the milk house he can often milk cows at the rate of nearly one cow per minute.

The Loose Housing System

THE LOOSE housing system offers a free, invigorating and healthful life for the dairy cow. Likewise, the loose housing system provides a highly flexible housing arrangement that can serve for one cow or any number up to the full capacity of the layout. In fact, the enlargement is usually easy and inexpensive. The buildings or portions of them may readily serve for many other purposes if they are not used by the dairy herd. Research tends to indicate the cow's ability to do well under this type of housing. High quality milk can be produced in a well planned and properly managed loose housing system. In keeping with the needs of the present, the loose housing system provides a low cost type of housing that is easily managed so as to reduce to a minimum the man hours of chore time.

Dairymen, used to the stanchion type of dairy barn, should study the loose housing system carefully before changing over to it. This type of housing presents an entirely different way of handling and caring for cows. Success will depend upon a carefully planned, complete and full scale change to the new system. It is of great importance that the plans and practices presented on this and the following pages be carefully followed if results comparable to those which have been obtained through research are to be realized.

From the illustrations which are included herein one can see that there are a wide variety of possible arrangements that may be adapted to the system.

Finally, once the system has been set up and placed in operation, one will have to be ready and willing to adapt himself and his operational practices to an entirely new system. He will find it necessary to remove horns from his cows.

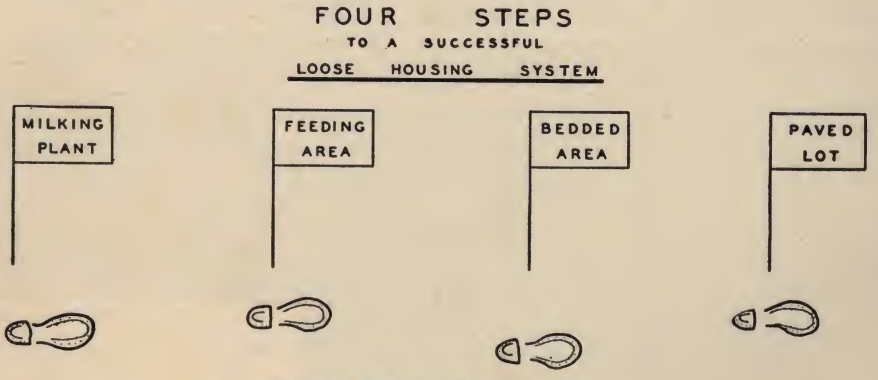


Fig. 20—Plan each step carefully.

So far as is known, those who have carried out their planning on the basis of the information on the following pages are having favorable results and now recommend the loose housing system.

The loose housing system requires that the dairyman put his cows first, and dresses warmly for doing his chores in low temperatures. Like all good dairymen, he will enjoy seeing his cows contented, quiet and thrifty; he will become a careful observer of the likes and dislikes of his cows, making adjustments in management or housing or equipment as needed and finding that it pays. Stiffness, swollen hocks and joints and udder injuries will be much reduced. Good appetites and efficient production at high levels can be obtained even in the coldest weather. In fact, there has been no measurable variation in production on a 4% fat corrected milk basis, due to weather changes or temperature changes, so long as the cows are fed all the good roughages they can eat. Cows in heat are easily detected. Calves born in pens on the deep manure pack of the bedded area respond to the motherly attention of their dam even at inside air temperatures of zero and below. If they are not claimed by their mother, they should be dried off and kept warm under an infra red heat lamp for a few hours or as required.

Most health departments realize fully the advantages of having milk produced in a well planned, sanitary milking parlor with a conveniently located milk house. Here the cows can be milked in a special milking room free of manure, animal odors, silage odors and hay dust. The important requirement is that the cows be clean so that premium grade A milk can be produced. In some sections of the region this system of housing has been approved by the health departments and sanitary building requirements

Fig. 21—The herd has complete freedom in a loose housing system. Note the comfort afforded in the bedded area. With an outside door open all of the time cows will spend hours in the sunshine each day.

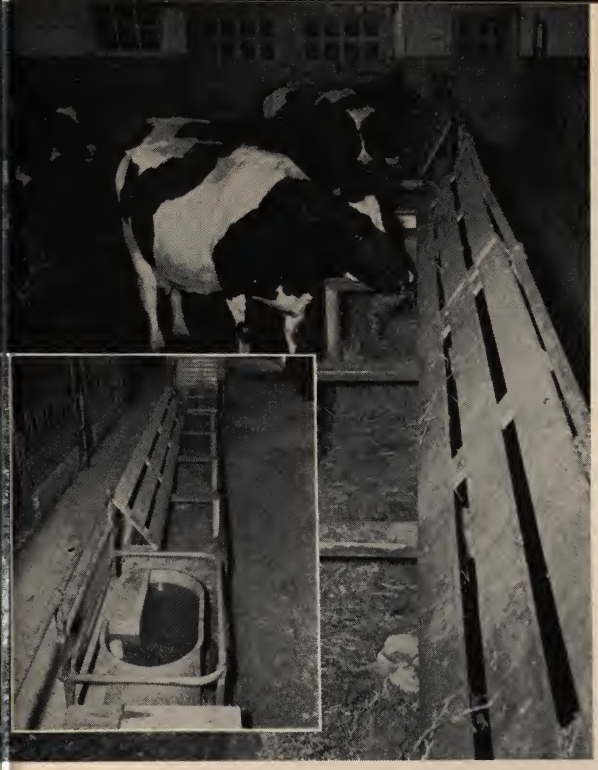


Fig. 22—The feeding area should be paved and cleaned daily or as needed. Float controlled water tank is convenient and deep feed mangers save feed. (Details are shown in Figure 26)

have been prepared. Dairy inspectors in most areas are observing the results on pilot farms where loose housing and various types of milking barns and milking parlors are being used. With proper plans and good management, farmers are proving that high quality milk can be produced, that cows can be kept clean and that suitable sanitary conditions can be maintained throughout. Code requirements are gradually being adjusted to allow the full development of the loose housing system. In setting up a loose housing system, as described in this publication and by following the recommended management practices, one can expect to win and hold a premium milk market. Before changing over to the new system it is desirable to check with the milk inspecting officials who are in charge of the enforcement of the local milk regulations, to make certain that they will approve milk produced by cows kept in a loose housing system.

Planning the Loose Housing System

THE operation of the loose housing system is easily understood if it is thought of as four separate units which may or may not be under one roof. If each unit is planned to serve efficiently for a herd up to a given size, then the four units may be expected to work together so as to provide a successful housing layout. These four units are (1) the feeding area and feed storage, (2) the bedded area, pen space and bedding storage, (3) the paved lot, and (4) the milking plant, which includes milking parlor or milking room, milk house, concentrate storage and utility room. In the southern part of the region the hay feeding and bedded areas have been successfully combined. Figure 31 shows a single building serving for the complete housing of a herd of 15 cows and young stock. Figure 32 shows a combination of buildings for a herd of 50 cows. Practical experience indicates that loose housing is adaptable for herds of any size.

When planning the loose housing system, be sure to follow the requirements for each unit as presented on the following pages. While there may be more than one answer to the questions involved, research has shown the wisdom of adhering to the recommended specifications and procedures if one wishes to get all the benefits which research has now demonstrated are possible.

1. The Feeding Area: Roughage in the form of hay or hay and silage is common for the dairy herd. The feeding area usually is a covered shed where the cows are fed their hay and it is where silage may be fed, although silage is often fed in feed bunks out in the paved yard. The hay is usually fed under cover as it tends to become less palatable after being rained on. This does not seem to affect silage when fresh silage is fed each day. With separate feeding areas for hay and silage it is possible to feed silage and hay once a day if desired. Hay mangers can be cleaned and filled at the same time silage is fed and the cows are bedded. Thus the chores can be done up quickly and at one time. Silage and hay can both be fed twice daily in the same manger if desired.

The cow is kept clean only if she can be prevented from lying down in the feeding area. A deep feed manger is necessary to prevent the cows from pulling out hay and lying on it. Since cows concentrate around this area, it is impossible to keep the space well bedded and clean. Therefore it is best paved with concrete and cleaned daily or at last once a week. If frozen, it should be cleaned out promptly as soon as it thaws. It can be cleaned by hand or more easily with a tractor mounted manure scoop. The manure from this feeding area can be hauled directly to the field or composted.

The design features of the feeding area are:

A. Location:

1. Locate the feeding area by the hay barn, either under or along side the stored hay, so as to shorten the distance the hay has to be moved sideways and downward to the manger. This is especially important where chopped hay is used.

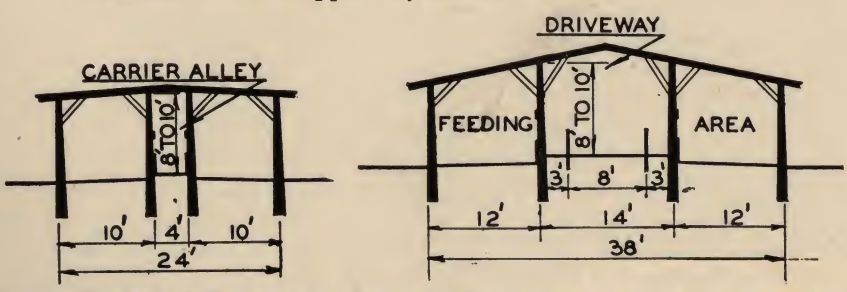


Fig. 23—Covered feeding areas for feeding from wagon, truck or carrier. Some Midwest dairymen now report success with feeding silage out in the paved barn yard while hay is fed under a roof. With this arrangement feeding once a day may be practiced.

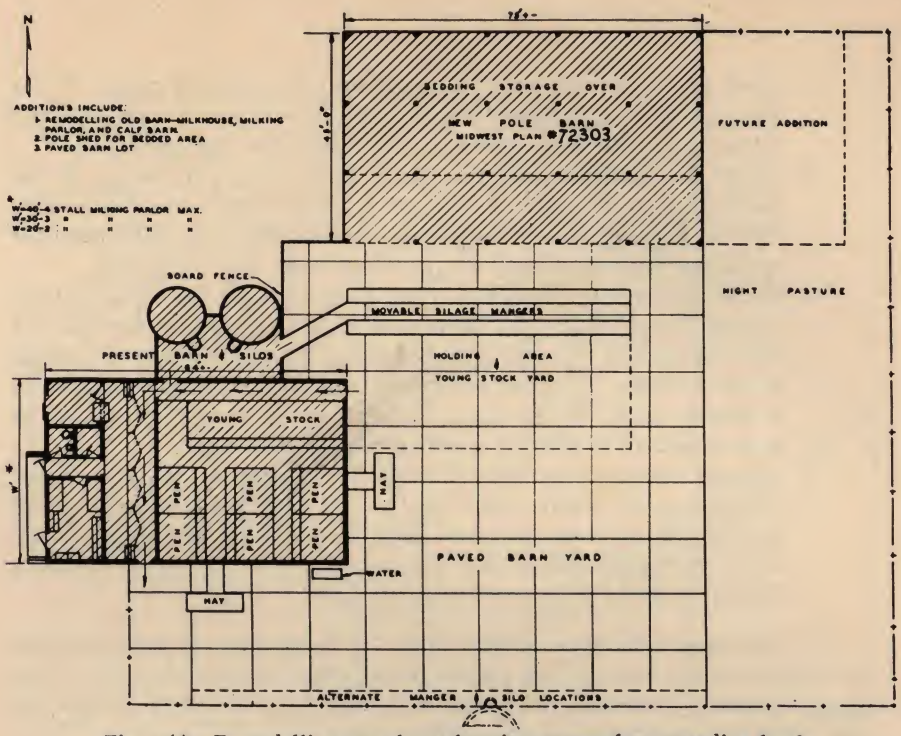
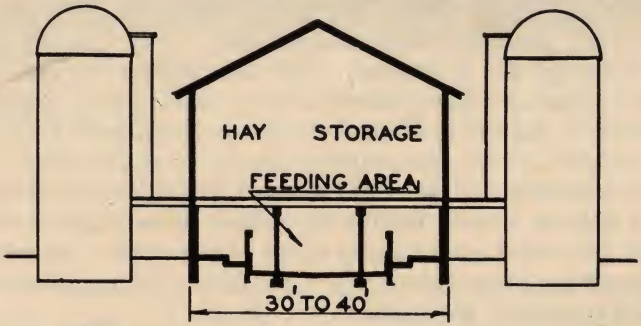


Fig. 24A—Remodelling to a loose housing system for expanding herd.



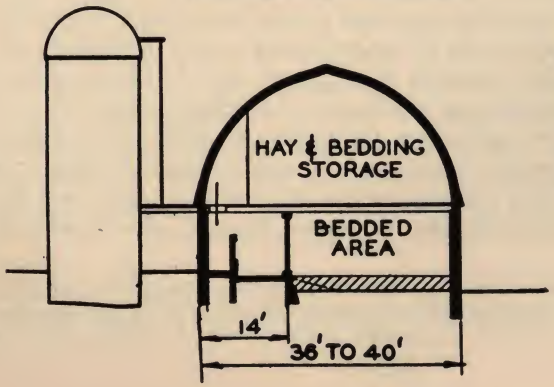


Fig. 24B—Hay storage over typical feeding areas that make good conversion arrangements for two story barns. Frequently bedded areas are arranged as shown.

2. Arrange the feeding area convenient to the milking parlor. It can then serve as a holding area for the cows during milking. This cleaned, covered area works out very well for this purpose.
3. Locate on south or east side of building so a part or all of the sidewalls may be omitted. Except in areas where snow may drift into the feeding area in deep drifts there seems to be little need for enclosing this area except to provide a roof and windbreak.
4. When converting a stanchion type dairy barn for the loose housing system the old barn will serve best as a feeding area because the hay storage and silos are already located for convenience in feeding at this location. The head room in an old barn is usually too low for a manure pack. In this case, a shed for the bedded area may be so arranged as to provide a well protected barnyard.
5. Arrange conveniently located silage feed bunks or mangers in the paved barn lot where silage may be hauled around for once a day feeding. In northern parts of Zone I it may be advisable to feed inside during periods of bad weather. The same is true on northern prairie locations because of drifting snow.

B. Drainage: The floor should slope ¼ to ½ inch to the foot from the manger to the back of the paved feeding area. At doorways and along open sided sheds this same slope may well continue some 10 to 15 feet out into the barn lot to keep out the surface water.

C. Hay and silage storage: Where hay alone is being fed in the manger, the feed alley is not essential. Where silage is also fed in this manger, a feed alley for the silage cart is necessary. This also requires a conveniently located silo. For those who have the facilities to feed with a wagon or trailer the location of the silo is of less importance. One should be able to drive under the chute to catch the silage as it is being thrown down. For those who use trench silos it means that the most favorable and convenient location for the silo can be used because the silage can be loaded with the tractor mounted fork and hauled directly to the feed mangers. All weather driveways to the silo, to the paved lot and to the feeding area are important when the ground is wet and not frozen.

The amount of hay storage required can be determined from Tables I and II. For instance, where the off pasture season is seven months of the year, and where generous amounts of silage are fed, 3,150 pounds of hay will be needed for each average sized cow. Providing storage for at least two tons of hay per cow will allow for shrinkage, picked over stems and a little over-run. Storage that can be used for either chopped, baled or loose hay has the advantage that one may adjust his operations as he sees fit and as equipment is available. The barn drying of hay may also be well worth arranging for.

Silo space adequate in size to meet the needs is essential, yet the silo must be small enough in diameter to prevent spoilage in warm weather.

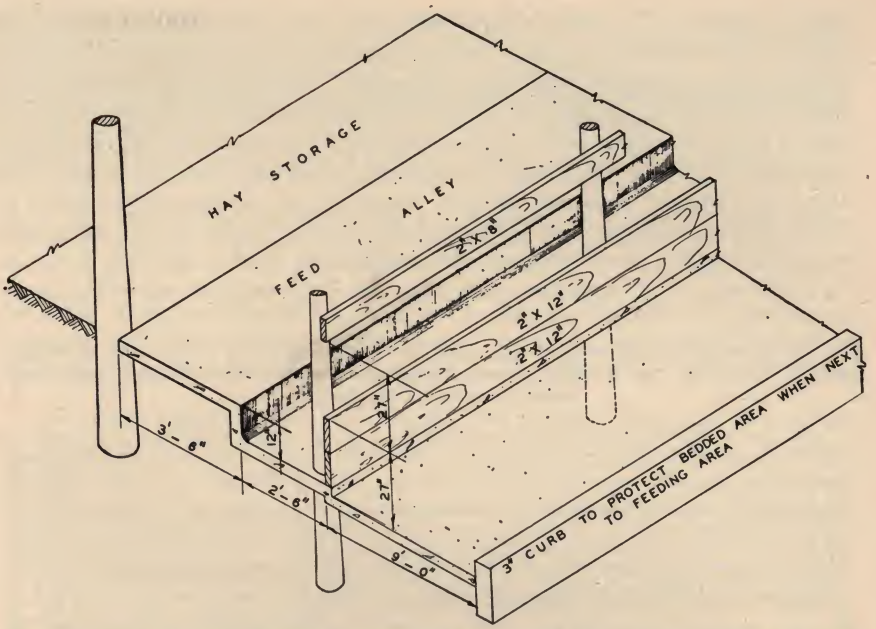


Fig. 25—The Western feeding fence works very well for hay and silage mangers. Note that the bottom of the manger is 6 inches above the platform level on which the cow stands. All posts set in concrete should be pressure treated with creosote. For hay feeding only, feed alley may be omitted. Feeding panels may also be made movable if desired.

D. Lighting: Good natural lighting will be available in open feeding area. However, in Zone 1 where doors are likely to be closed in extremely cold weather, some windows will be necessary. Perhaps 2 to 4 square feet of window glass area per cow will be satisfactory. Electric lights will be a great convenience at chore time in the winter months and for use on dark days.

E. Ventilation: Where the feeding area is closed in and outside doors are shut at night in extremely cold weather and during blizzards, there may be an accumulation of frost on the outside walls and ceiling. This will disappear quickly when the doors are opened. Construction of side walls with barn boards without battens will permit considerable ventilation even if the doors are closed, but the space between the boards should not be so wide as to permit objectionable amounts of snow to drift through. There is no reason for attempting to operate the feeding area as a warm barn as this will increase frost and condensation and will not add to the comfort of the cattle. They respond better to dry, cold fresh air than to damp, cold air.

F. Water: Water for the dairy herd may be supplied from a small four foot tank, refilled by float valve, banked in winter and fed by supply line

coming up from the ground underneath the tank. It is best located in the feeding area near the feeding manger, but separated from it by a guard to keep hay out of the tank. Some farmers are successfully using a large stock tank, setting outside, but banked and mostly covered in winter. If the tank is pumped full of well water at 50° to 55° every morning and nearly emptied at night, trouble with ice will only occur in very cold weather. A tank heater may be required for brief periods of extremely cold weather. If a frost proof overflow is provided for the tank a small by-pass valve can be opened slightly. Fresh water from the well will tend to heat the water in the tank, reduce ice formation and keep the float valve in working condi-

Fig. 26—Details of feed manger that does not waste hay and a water tank with float control. The tank may be banked and partly covered in winter. Water supply and overflow enters from below.

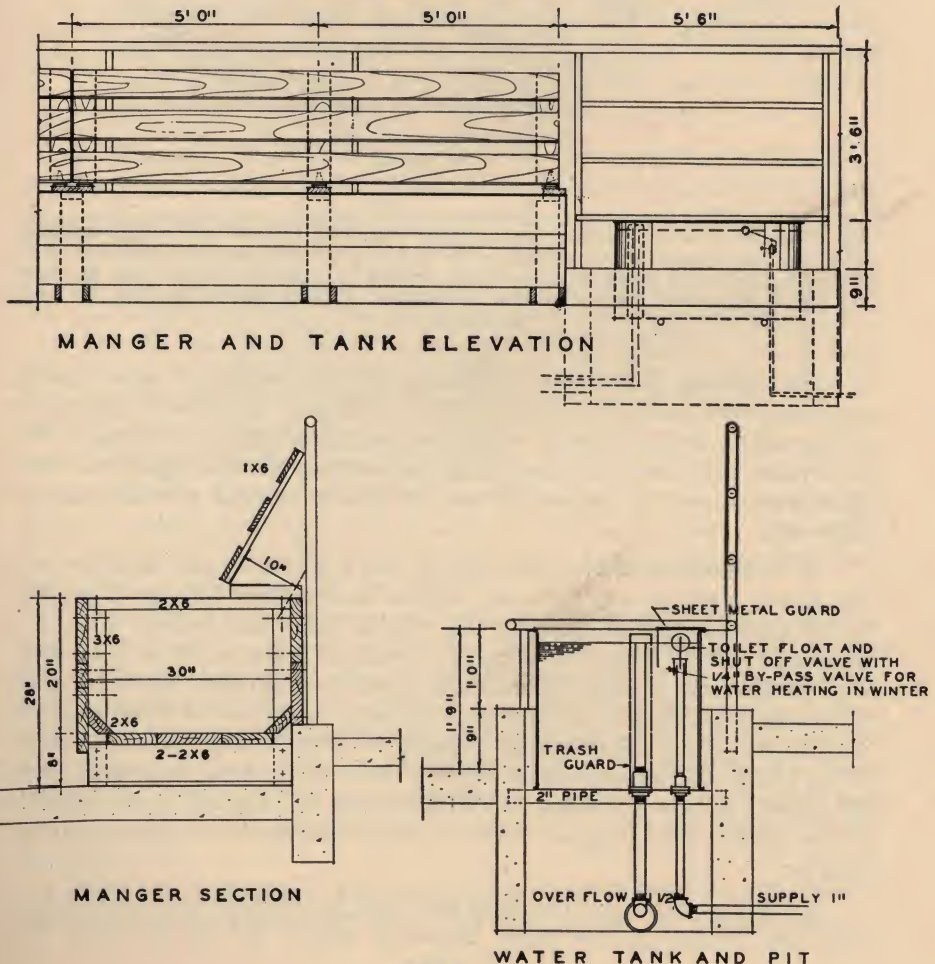


Fig. 27—One story buildings are especially well adapted to the loose housing system. Here a sunny, well drained, wind protected barn yard is essential. (See Figure 1 for research barn floor plan)

tion. For cows acclimated to cold, loose housing conditions there is no evidence justifying heating fresh spring or deep well water except to avoid freezing and to keep it available at all times.

G. Feed mangers: The feed manger for feeding silage and hay should be so constructed that hay cannot be pulled back onto the floor. A simple feeding fence is successful when used along a manger that has a bottom 8 inches above the floor and 30 inches wide. This feeding fence has a tight plank front, 26 to 28 inches high. There is then space for the cow's head and a rail 4½ feet above the floor. A feed alley may or may not be provided. If a feed cart is used for feeding, the 3½ foot feed alley is necessary. However, where silage is fed outdoors in feed bunks from a wagon or truck or by tractor fork, then the hay manger can often be filled from the hay loft without the use of a feed alley.

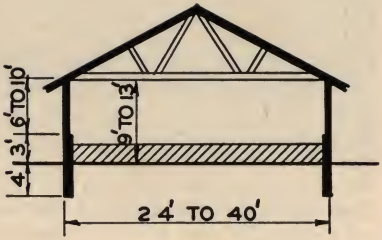
The space required per cow where hay and silage are both fed at the same manger is from 27 to 30 inches. This same requirement would hold for feed bunks outside or for an outside feeding fence where silage is fed. Hay manger space for self feeding may be 24 inches or even 18 inches per cow. Where space is limited, the feeding should be generous and all of the hay should be good.

2. The Bedded Area: It is the bedded area which is largely responsible for the favorable health record of cows kept in the loose housing system. Cows rest comfortably and quietly on the warm, soft, well bedded manure pack after spending most of the day time being milked, at the feed mangers and out in the fresh air and sunshine of the barn lot.

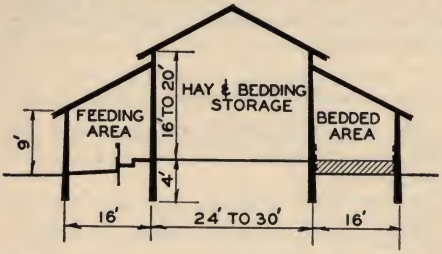
The planning and management of the bedded area has much to do with the comfort and cleanliness of the cows. When the bedded area is used only as a resting place for the cows, about 12 pounds of bedding such as straw will be required per day. The performance of herds under test conditions has demonstrated the bedded area provides best housing conditions when it is an uninsulated shelter with a large outside door to the east or south, open at all times. Roof ventilators or louvers in the gable ends of shelters having tight siding will help keep the bedding dry.

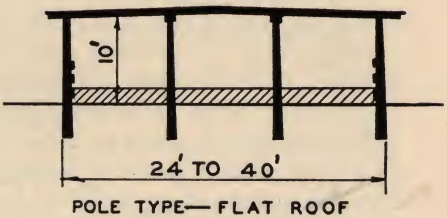
The bedded area is best if quite wide and free from restrictive passages or concentrated traffic. Drafts caused by two door openings at opposite ends

Fig. 28—Below: Bedded areas with floor level bedding storage. Top section for small herd has feeding on one side and bedded area on other side of hay and bedding storage. Right: Bedded areas in one story structures. Here bedding would be stored at one end or elsewhere. Lower right: Bedding storage over bedded area.

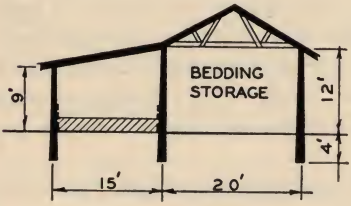


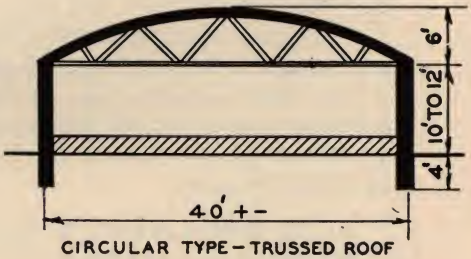
GABLE TYPE-TRUSSED ROOF



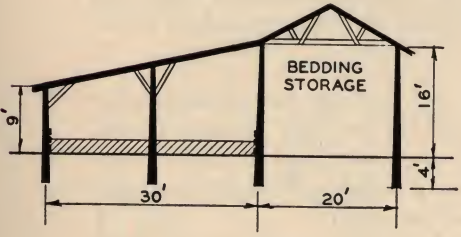


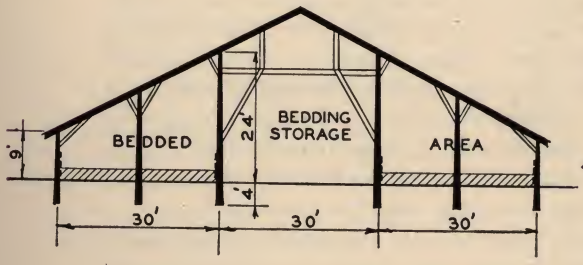
POLE TYPE— FLAT ROOF

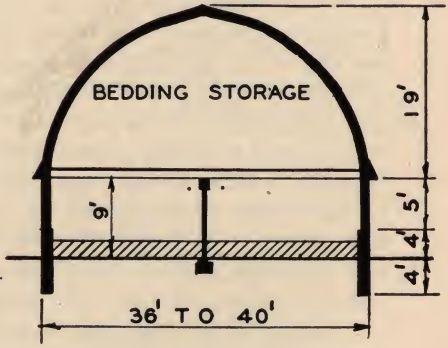




CIRCULAR TYPE-TRUSSED ROOF







of the bedded area should be avoided. The best control of traffic can be obtained if cows enter the bedded area from the feeding area.

With the bedded area operated as an open, uninsulated shelter, the condition of the bedding, and the bedding requirements, are affected by weather. Cold, dry weather will result in crisp bedding that is easy to keep clean; while moist, warm weather will result in increased bedding requirements. When bedding is scarce, the amount needed can be reduced by placing exposed droppings along the outside wall once a day. This will make better manure along the wall where droppings do not usually accumulate as much as elsewhere.

The following suggestions will help when planning the bedded area:

A. Location: Where the bedded area is located in the same building as the feeding area and perhaps the milking parlor, it is best to have it at the opposite end of the building from the milking parlor. In fact, where the manure is allowed to remain in the bedded area until fall, it is best to keep the cows off it in the summer. If undisturbed, flies are not likely to develop here and if they should they can be controlled with fly spray. It is not advisable to hold cows on the manure pack of the bedded area to wait their turn through the milking plant. They will mess up the bedded area and track enough straw into the milking parlor to plug drains.

The plan of having a separate building for the bedded area works well, so long as it fits in with a barn lot improvement program of paving, and there is wind protection from prevailing winds. Except in areas of deep snow fall it is not objectionable to have the cow go out of doors to get from one part of her housing unit to the other.

B. Space: The floor space in the bedded area should be at least 60 square feet per cow. In herds of 20 cows or less, the heifers and dry cows may run in with the cows and be given the same floor allowance. For large herds it may be desirable to separate the milking cows from the others. From 20 to 30 square feet per cow will also be needed for calf pens. Usually a temporary hospital stall should also be provided. All pen partitions should be tight to prevent drafts and they should be raised as the manure pack builds up. They will likewise need to be easily removed to facilitate operating the power loader in removing the manure from the bedded area.

The operation of the power loader requires conveniently located doorways wide enough and high enough for the loader. The usual door, 10 feet wide and 8 feet high, hung in an opening 10 feet wide and 9 feet high, works very well. This keeps the door free at the bottom. Some planks will be needed across the door ways not used in winter to keep the manure from pushing the doors open. Be sure to eliminate any posts or walls across these doorways which will interfere with the operation of the power loader.

Most tractor mounted loaders operate only on solid footing. Therefore head room for the loader and for the operator on the tractor can be figured from the ground floor rather than from the top of the two to four foot

manure pack. A ceiling height of 9 or 10 feet will be enough room for most power loaders. See Figure 8.

A bedded area free of posts is easiest to clean. However, a shed built with pressure treated, creosoted posts supporting the roof may often be much less expensive, and therefore more practical, than buildings with trusses or self supporting arches. A minimum post spacing of 12 or 14 feet is suggested. With doors arranged for access to all parts of the shed, it can be cleaned very quickly and easily.

C. Bedding storage: Bedding storage adjoining the bedded area and at floor level or bedding storage overhead in the bedded area is most convenient. Of course, bedding can be stored elsewhere or if baled, it can be stacked out of doors and covered with suitable paper to keep it dry. It is important to have enough bedding conveniently located and protected from the weather to provide a dependable supply throughout the entire housing season. About 12 pounds of straw or its equivalent of bedding are required per cow, per day. See Table II for the amount needed in each zone, per season. Bedding requirements will be less in the less humid parts of the region.

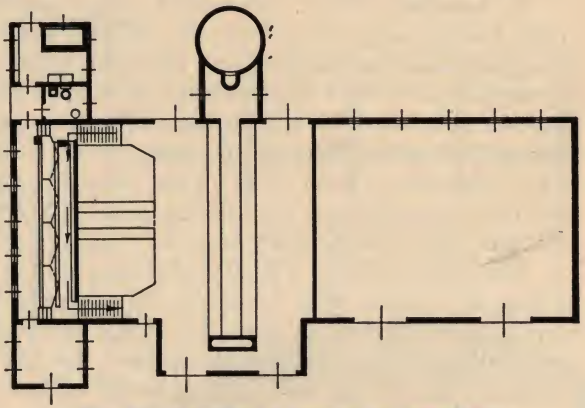


Fig. 29—A typical 2 story barn remodeling plan for loose housing.

D. The foundations and any post supports should be planned for the pressure of from 3 to 4 feet of manure. Any wood exposed to moisture and decay hazards should be of decay resistant wood or wood that is pressure treated with creosote.

E. The floor: The floor of the bedded area may be of hard packed clay or well packed, finely ground limestone or concrete. Drainage is not needed as the bedding will soak up the liquids. Outside surface water should be led away from the buildings with proper grading to prevent seepage and entrance through the doorways.

F. Ventilation: The open door policy for the bedded area assures a generous supply of fresh air at all times. Circulation can be secured through cracks between barn boards, hay chutes, roof ventilators or louvered openings in the gable ends. Provide enough ventilation to keep the walls and ceiling dry. For a few days during extreme cold weather there may be

Fig. 30—Interior view of a 3 stall tandem milking parlor. Note interior wall finish of ceramic tile.

some formation of frost on the interior. Any dripping from the frost usually lasts only for a short time when the weather moderates and the sun shines.

G. Lighting: Even with the door open, it is suggested that some windows, perhaps 3 to 4 square feet per cow, be provided. Electric lights are a most desirable feature. Cows can often be attracted to the milking parlor in the morning by turning on the lights in the bedded and holding areas. Such light also allows one to inspect his herd quickly at night.

H. Hospital stalls: Since hospital stalls are often needed for isolating individual animals from the herd, two wood gate panels 4 feet high and say 12 feet long, hinged together at one end will be convenient. These panels could be cleaned and sterilized with a lye solution after use, if there is any danger of spreading disease. A generous layer of fresh bedding should cover the pen floor after each time it is used. In the smaller herds where dry cows, young stock and milking cows are run together, these pens are especially desirable at calving time. In the larger herds, a special lot for dry cows and young stock is most desirable. This lot should have proper housing and a convenient feeding arrangement with ample pens for isolation of new animals to be brought into the herd and for freshening.

I. Calf pens: Calf pens are needed on every dairy farm and space along or next to the bedded area is often satisfactory. Partitions that are easily removable and built so they can be raised as manure accumulates, will greatly simplify cleaning if it can be done with a power loader. A deep manure pack is just as essential for calf comfort as for cow comfort. It is a good plan to locate calf pens where they can get sunshine or plan to let the calves out in the lot for exercise on sunny days. The feed manger and feed alley for the calves are best arranged so the cows cannot reach the feed or touch the calves.

3. The Barn Lot: Dairy cows make good use of the wind protected barn lot, the fresh air and the sunshine. In fact, they often remain out in tem-

peratures as low as 20 degrees below zero and at times when it is snowing or the wind is blowing. The only measurable effect of cold weather on the cow in the loose housing system is in the amount of roughage she eats.

The requirements for a suitable barn lot are listed below:

A. Wind protection: Protection against prevailing winds is most desirable. A lot on the south or east of the barn usually works out quite well. A board fence, cattle shed for bedded area or for feeding area arranged to protect the lot will increase the value of the lot and its use by the cows. A grove of trees also helps to stop the wind and snow.

B. Area required: A suggested standard is 100 square feet of paved barn yard per cow. If silage or silage and hay are fed in feed bunks and mangers in the yards, more area will be better. A large, sodded yard can be added when the ground is firm as some cows will prefer lying out in the open in mild spring weather.

C. Surfacing: The most satisfactory surfacing for the barn yard used by the cattle is concrete. A pavement consisting of 4 inches of good concrete placed over a 6 inch gravel or sand fill is not unreasonable in cost in most areas. Some farmers are trying finely crushed limestone rolled down

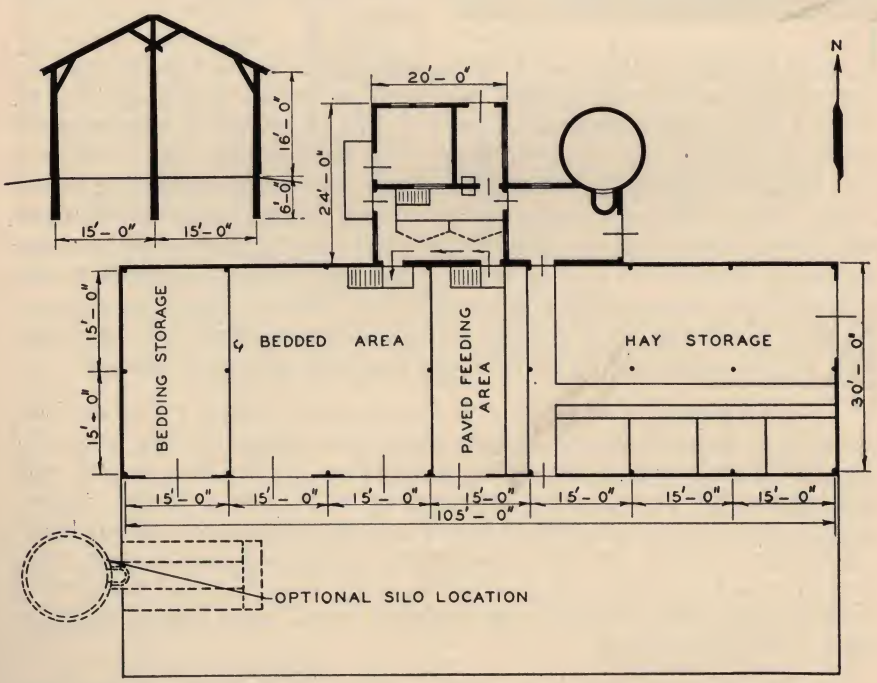


Fig. 31—A loose housing system adaptable to pole or frame construction (see Figure 27) for fifteen cows plus heifers and young stock.

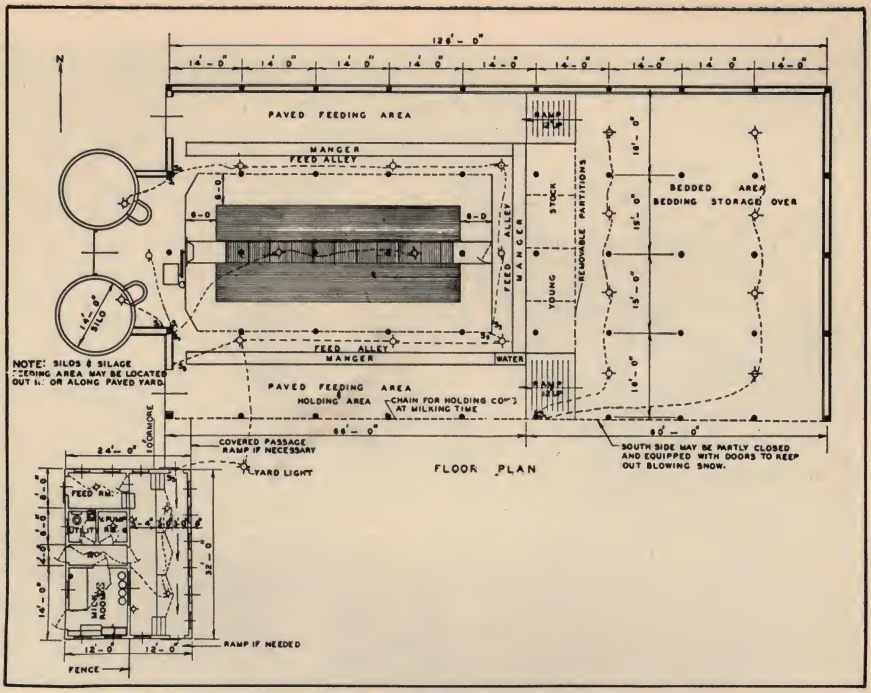


Fig. 32a—A loose housing system adaptable to pole or frame construction for thirty cows plus heifers and young stock.

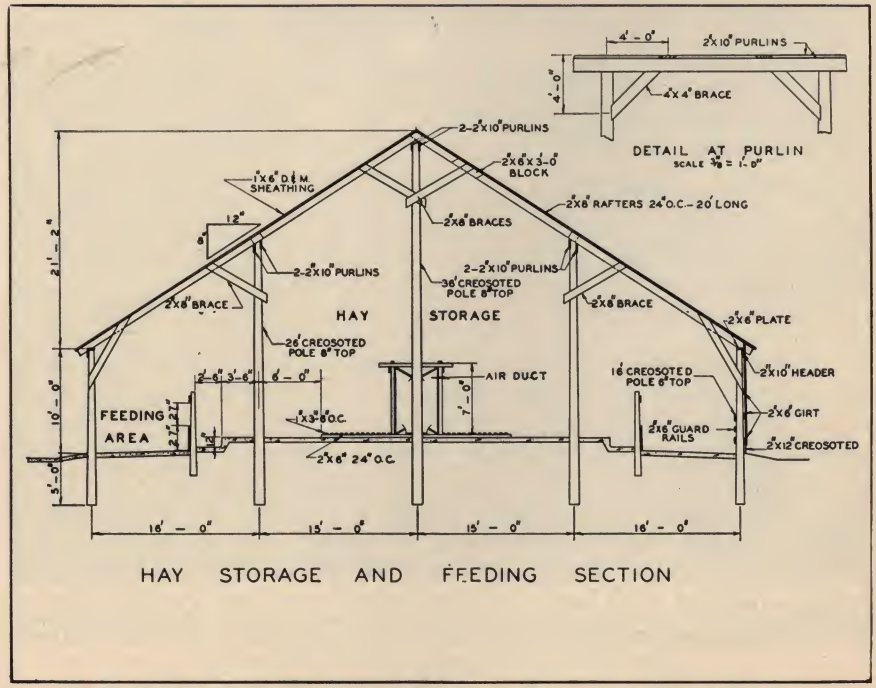


Fig. 32b—Framing for the feeding end of the plan in Figure 32a.

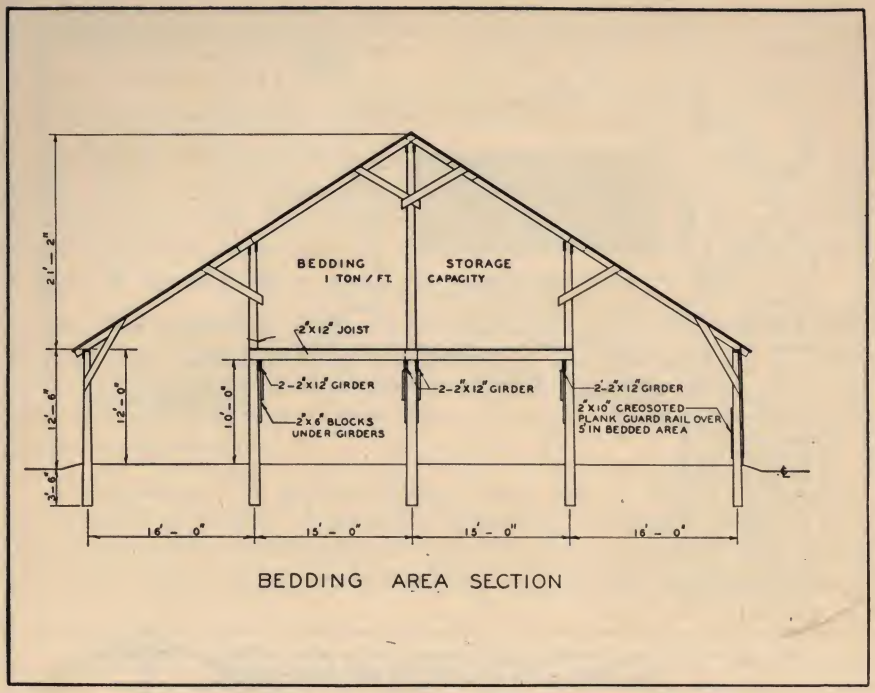


Fig. 32c—Framing in the bedded area of the plan in Figure 32a.

when wet. We will soon know how these less expensive materials work out. Concrete however, is easy to clean, dependable, hard surfaced at all times and is not easily damaged by weather, water or tractor.

D. Drainage: The paved barn lot should have a slope of 1 foot per 100 feet to a sodded waterway with generous capacity. The slope should be away from all buildings. Surface water drains require frostproof catch basin and a generous size tile drain. While they can be made to work, they are not generally recommended.

E. Fencing: The barn lot should be arranged for use in summer as well as in winter. Two lots separating milked cows from those not milked should be worked out for larger herds so both groups of cattle can find shelter either in the feeding area or in the bedded area. One of these lots would be the holding area. The lots should be arranged so manure spreaders and tractor loaders can be together in the same lot rather than attempting to dump manure in the spreader over the fence. Suitable fencing for the paved barn lot would consist of wood planks fastened to steel or pressure treated, creosoted wood posts. One inch rough sawed oak boards or similar strong wood may be used if posts are 6 or 8 feet apart. For new animals

Fig. 33—The elevated milking stall makes good milking easy.

Fig. 34—Cows line up to wait their turn at the milking parlor door. They take the same position with a variation of one or two places each time they are milked. Here the feeding area also serves for the holding area.

being brought into the herd, a separate pen and shelter next to the main lot is suggested. In this way, strange animals can become accustomed to their new home quickly and without the usual fuss. A similar location can be arranged for the bull. Here a safe paddock fence and safety breeding chute are necessary, especially if mature animals are to be kept.

4. **The Farm Milking Plant:** The loose housing system requires a place to milk several cows each milking, in each stall. This relatively small milking room, barn, or parlor with attached milk house is low in cost per cow although it is the one building or part of a building in the loose housing system that should be built to exacting sanitary requirements.

In order to keep milked cows separated from the rest of the herd, a partly covered, paved and clean holding area just outside the entrance door to the milking room is required. This may often be a part of the feeding area and if the milking plant is a separate building, the holding area may include a sheltered passage from the feeding area and extending ten to twenty feet out to the farm milking plant.

For loose housing it is generally considered best to feed concentrates while the cows are being milked. This requires a convenient feed storage, either above or at ground floor level. Hopper bins have been devised to spout feed down to each individual feed trough where it can be metered out as required. However, one then has the problem of getting the feed elevated to the second floor.

In the northern zones some heat is desirable in the milk house and milking room. Insulated construction will help maintain higher temperatures. However, one may dress warmer, use lime on the milking room floor and a frost proof hydrant in the milk house. Where the volume of milk is high, the milk house may remain moderately warm especially if a mechanical cooler is used. A cold milking room soon warms up when it is filled with cows. If it is of tight construction, ventilation will be required.

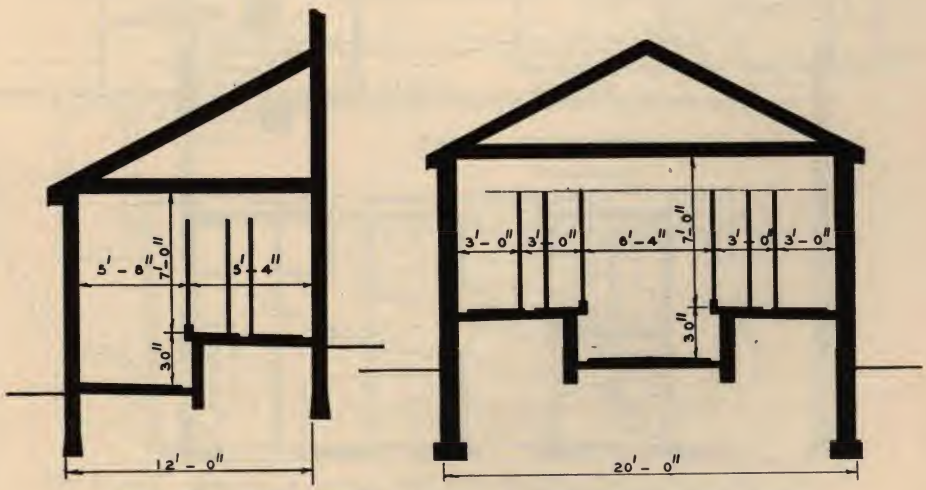
Milking machines of two types are generally available for milking parlors and milking barns. There is the bucket type milker and the milk line or releaser type which will take the milk into the milk house by pipeline. While the latter type is more expensive, the operator is relieved of the chore of carrying the milk. Since milking machines are considered as personal property they are taken out when a farm is sold or a tenant moves. It therefore, is considered good practice to plan all milking rooms, barns and parlors so either the bucket type or the direct milk house delivery type of milker can be used.

The plan of milking cows may be changed in the use of the milking barn or parlor in that the milking time may be extended to two hours or more so a smaller milking parlor, less equipment and less help may be needed. On a two man farm this may mean that one can milk mornings and the other evenings during the winter. In the rush season one man can milk while the other continues field operations. It will also permit vacations.

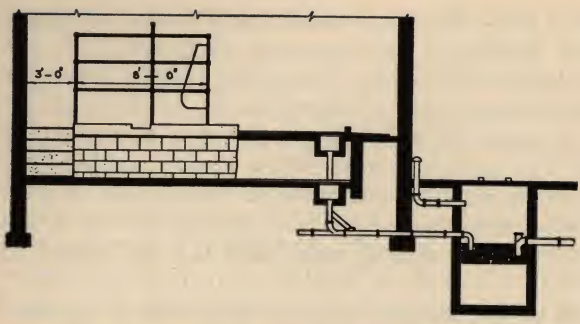
The floor level system: Here the cows stand in stanchions or stalls and are milked by the operator standing at the same level as the cow. The cows may walk through after being milked or they may be released from the stanchion and back out depending on the arrangement. In the walk-through stalls where the stanchions open up to let the cows out it is usually the practice to change one or two cows at a time. Allow 8 cows per hour per stall if they are to have time to eat their concentrates. The number of stalls will depend upon the number to be milked per hour and this in turn is also dependent upon the capacity of the milking equipment and the amount of help available.

The floor level parlor is inexpensive, simple to build and is operated similar to the stanchion barn so far as milking goes. However, the cows must be changed several times during each milking and if the milkers are to be kept going continuously, only a part of the cows can be changed each time. With this plan one man can use 6 to 10 stalls to good advantage and if he has help he may want from 8 to 12 or 16 stalls. In this way, less time is lost in making changes. See Figures 1 and 40.

The elevated stall system: This system of production line milking where the operator stands erect and carries out all of the milking operations with the cow standing at a level of 30 inches above that on which he stands, has a number of advantages. All work is done in full view of the operator. Convenient rope and pulley arrangements make it possible to open the self closing doors for the cows to enter and leave. One cow is changed at a time because the turnover is quick and easy. With this type of milking stall one can operate for a longer time without fatigue and he can do a better job of milking.



Figs. 35a and 35b—Milking parlor cross section of one and two rows of milking parlor stalls.



SECTION OF MILKING PARLOR AND SEPTIC TANK

Fig. 36—Milking parlor section showing drains and wash water disposal. The walls are shown as masonry but other suitable materials may be used.

There are several arrangements for the elevated stalls as shown in Figures 39 and 40. While these various arrangements are being tested for efficiency, at the present one can only pick the plan which best fits a given situation.

In planning the arrangement for the elevated milking stalls it is a good plan to get the operator's floor at the same level as the milk house floor. In this way, the work is made much easier for the operator especially if he must carry milk. Cows may have to be ramped up at least part of the 30 inches but this is not difficult for active cows kept in the loose housing system. Such arrangement also calls for a higher ceiling. Of course, where the ceiling is low, an operators pit can be provided at a lower elevation.

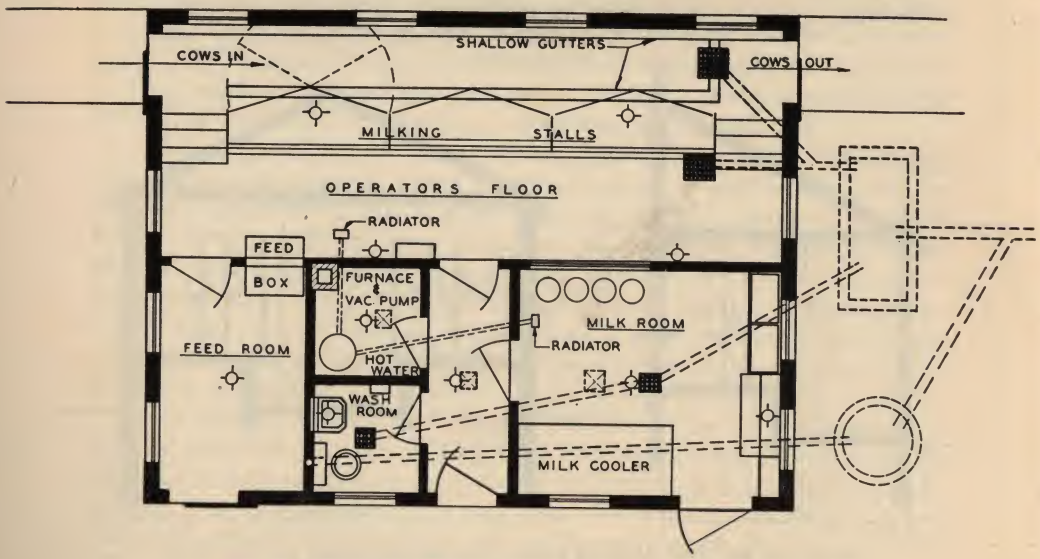


Fig. 37—Typical 3 stall tandem type farm milking plant.

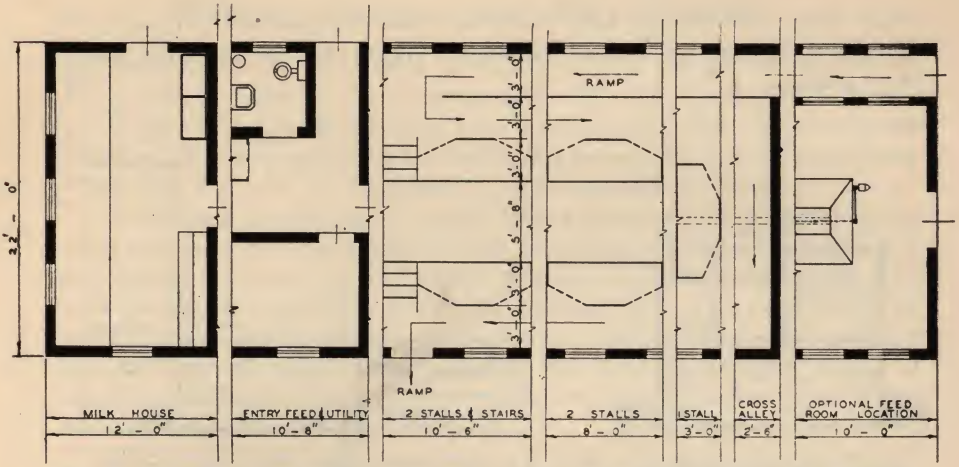


Fig. 38—The "U" type milking parlor may save steps if the arrangement is efficient. If end stall is not used increase cross alley width to 3'–6". This is important.

Because of the continuous operation of the elevated stall parlor one can determine quite accurately the number of stalls he needs for a given capacity. For instance, just as in the floor level parlor we estimate 8 cows per stall, per hour. Two stalls would have a maximum capacity of 16 per

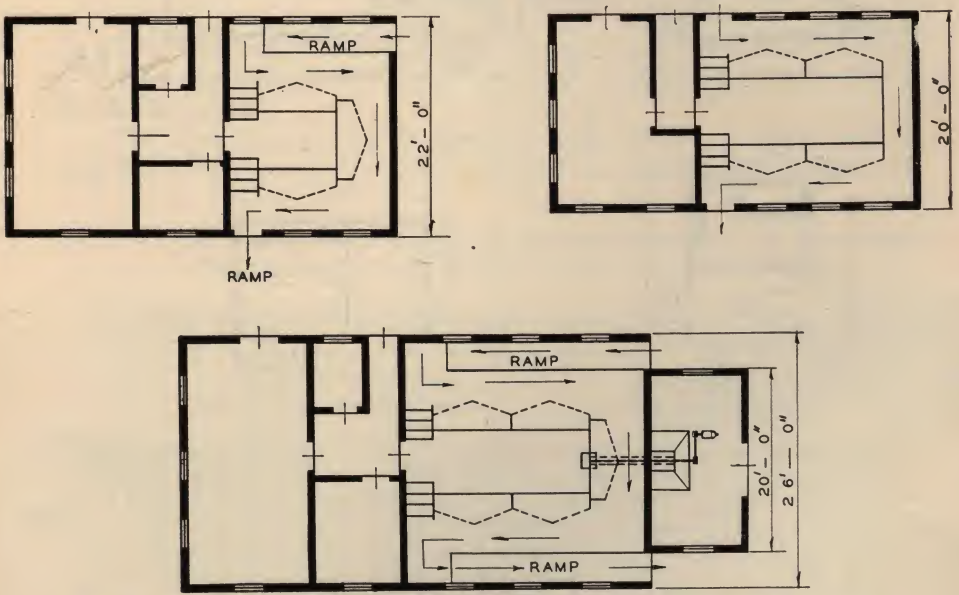


Fig. 39—"U" type—2, 3, 4, or 5 stall farm milking plants. Note that width is dependent upon number of alleys required for circulation of cows.

hour, three stalls 24 per hour and four stalls, 32 per hour. This can be doubled if the cows are fed and washed just before they come into the parlor to be milked.

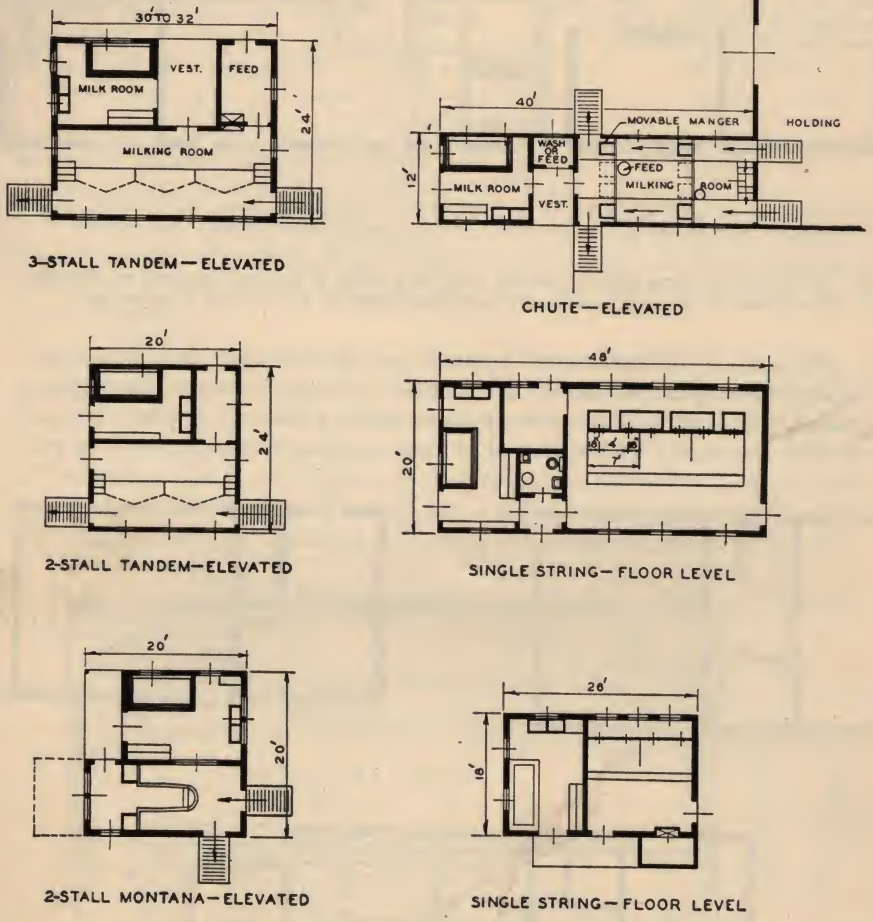


Fig. 40—Typical farm milking plant layouts: 1. 3 stall tandem parlor with elevated stalls; 2. 2 stall tandem parlor with elevated stalls; 3. 2 stall Montana type parlor with elevated stalls; 4. Chute type parlor with elevated stalls; 5. 6 stall floor level milking parlor; 6. 4 stall floor level milking parlor.

Milking Parlors and Milk Houses

REGARDLESS OF THE SIZE of the dairy herd, the dairy farmer is expected to produce a clean food product. The U.S. Public Health Service has prepared a suggested standard milk ordinance and milk code as a guide to cities adopting regulations. It may be best to go over new or remodeling plans with the milk plant operator or field man before building.

It certainly is reasonable to require that milk be produced from healthy, clean cows and that clean utensils and methods be used that will insure a low bacteria content and the complete absence of foreign material. The milk should be cooled as quickly as possible after it is produced. The standard milk code in general is quite reasonable and those who interpret and enforce it should also be reasonable. The willingness of the farmer to meet the sanitary standards largely determines the quality of the milk when it is delivered from the farm.

Keeping the barn clean and sanitary is often of greater importance than the method of housing. Concrete floors, adequate bedding, daily removal of manure from stanchion barns and effective drainage are essential in keeping cows clean. Swine, sheep, and poultry should not be permitted in the dairy barn. If horses are housed in the dairy barn, they may have to be separated by a tight partition from the area where the cows are milked.

The Milk House

MOST milk regulations require that the milk be removed from the barn soon after it is produced. Straining milk is not generally permitted in the milking barn.

The separating, cooling or storage of milk requires a special room or milk house which usually is located outside of the milking barn. Today, such

Fig. 41—A typical milk house located on the clean side of the barn. This is a complete dairy unit. Low roof meets needs for baled or chopped hay.

a room is an essential on any dairy farm, and is worth what it costs, if for no other reason than for the convenience it provides in handling milk and in washing and storing the milking utensils.

The milk house is customarily attached to or located near the milking barn. Much time and labor can be saved by locating it near the milking area. It should have tight walls and be separated from the barn by an open or ventilated passage and by two self closing doors. A safe water supply, hot water, cooling tank, floor drainage, and convenient arrangements for loading milk are all highly essential.

With most milk codes the following rules are almost sure to apply. The milk house should have a smooth concrete floor with a 4″ drain. The walls and ceilings must be smooth, water-proof, suitable for painting and easy to clean. The room should be well lighted and ventilated. All windows should be opened when desired and the ventilator and windows should be screened. Doors should open outward to keep out flies and not lead directly into the barn or into any room used for living purposes. Necessary equipment also includes a wash tank with at least two sections. Some means of heat is necessary to provide hot water and to keep the room temperature above freezing in winter. Every milk house should have a cooling tank big enough to handle both night and morning milk at the same time. A suggested milk house with interior arrangement is shown on each dairy barn plan in this publication.

It is well to consult the county agricultural agent or the College of Agriculture in your state, for detailed milk house plans.

Building and Maintaining the Barn

ONCE the decision has been made to build or remodel a dairy barn, and after all the details of planning have been carried out, the actual construction of the barn will follow. The work may be done in a number of different ways:

1. **By the farm owner and his help.** The farm owner should have some ability, experience, tools and time, in order to carry out the construction work in an efficient and workmanlike manner. Some skilled labor such as a carpenter or brick mason will often need to be hired for parts of the project which the farmer is not equipped to do. At the expense of more time, the farmer can sometimes utilize used materials, or local and less expensive materials, without impairing the quality of construction or the usefulness of the structure. Cash costs can often be reduced in this way.

2. **By a carpenter or builder** on a material cost, plus labor cost, plus a fixed profit, determined in advance.

This plan is followed in many areas where well established, reliable local builders are available, as they take considerable pride in their work and

in the completion of the project within their estimate of the cost. In following this plan, either the owner or the contractor can purchase the materials, the contractor furnishes the labor and the supervision, while the farmer should carefully inspect the work as it progresses. Inspection should be simple because the owner and the contractor are more or less partners working for the same objectives.

3. By a contractor on a lump sum bid and contract. With this plan, complete plans and specifications should be provided in advance and careful supervision by the owner carried out during construction.

Complete mutual understanding, preferably in writing, in advance of signing the contract, will do much to help the situation when a lump sum contractor with a low bid tries to erect a good building and at the same time, keep costs down, while the owner naturally attempts to protect his interest and to get all he can for his money. Whatever the arrangements between the owner and the contractor, the contract should include plans, specifications and a listing of all special agreements, some of which are referred to below.

Each of the methods has its advantages and disadvantages. However, for every job there will be an arrangement that will work out best. Regardless of the plan followed, the following considerations should be checked off before closing the deal and starting construction.

Some Construction Pointers. Changes in plan after construction starts can often be made at little cost and trouble to the contractor. Sometimes, however, these changes are costly and annoying, especially if too numerous. It is better to have the plan completely made before entering into a final agreement with the builders.

Inspection services are often provided by milk companies, fire insurance companies, state sanitary engineers, state industrial commissions or other similar public agencies. Any good contractor welcomes such inspections by agencies operating in the locality, especially if it is understood before he takes the contract, that they are to be used. Likewise, both the owner and the contractor can well afford to follow codes and rules which are in effect in the area.

Other details best thought of in advance of closing the deal with the builder include arrangements for accident insurance; arrangement for fire and windstorm insurance during construction; method of payment for work; date of completion of contract; bond to guarantee completion date if desired; holding back of payments pending inspection of plumbing or wiring; and, in case of disagreement on some part of the project, provisions for arbitration. Arbitration can best be left to a three man committee where the contractor and the owner each chooses a representative and these two choose a third member of the committee.

Maintenance. The owner can well afford to devote time to the project while construction is under way. First he will want to know that the layout is being made as planned, that the materials and workmanship are satisfactory throughout and that all work is being done as agreed upon. This is the owner's privilege and the good builder or contractor will appreciate the owner's interest.

Low maintenance or upkeep costs are obtained when the original construction is of good quality. Good construction will require more patience on the part of the owner and a little more effort on the part of the builder. The cost may be higher, but it will usually prove most economical in the end.

Specialized and more highly mechanized farm buildings often increase the first cost as well as the maintenance cost. All mechanical equipment should be installed so as to give many years of service and keep maintenance costs as low as possible.

Proper upkeep of buildings and equipment always prove cheapest in the long run. Careful management can do much to keep down repairs. Maintenance measures found to be good practice in the preservation of buildings and equipment should be regularly and methodically applied. The pride of ownership, improved appearance and saving of time and money are added dividends for building owners who keep everything in good repair.

Neglect is costly, and it may become a burden to those purchasing farms with run-down buildings. Where buildings and equipment are not repaired and given reasonable care, the amount of deferred maintenance required may actually equal the cost of a new layout. The cost of repairing neglected buildings and installing equipment such as electrical wiring should be deducted from building values which are based on their original cost, less depreciation to present age. In fact, one should consider the adapability of the farm buildings to modern requirements when estimating their value to a farm.

Fig. 42—Remodeling, repair work and enlargement make the old barn fit present day needs.

Cost of Housing Dairy Cattle

THE annual cost of having a dairy barn may be computed from the value of the following:

Interest on investment—2 to 5%, taxes and insurance—1 to 1½%, repairs and upkeep—1 to 2%, depreciation—1½ to 3%.

A fair average annual cost would be about 8% based upon the present value of the building as it is being used. If it is remodeled or rebuilt, the present value would be increased accordingly, and the new total would then form the basis for determining the yearly cost.

Keeping building costs in balance with income is good practice on any farm. A safe rule is to keep the total housing costs at or under the annual gross income for the dairy herd. If one were to allow 8% of his gross income from the sale of dairy products for dairy cattle housing and charge 8% on his building investment, he would have a building investment equal to the annual gross income. In other words, 8% of each dollar of income would contribute 8 cents towards housing. This same 8 cents would pay the 8% charges on one dollar of building investment. While this may not be a hard and fast rule it can be used as a guide in determining what a reasonable investment cost might be for the housing of the dairy cow, her feed and the milk she produces.

Should barn costs remain high and milk prices low, only the high producing, high income herds will be able to afford the high cost of new housing. This means that one with a low income producing herd who is interested in making building improvements, must first increase his production and income per animal through better herd management, better home grown feed and improved milk quality.

Plan Service

COMPLETE plans are essential to the construction of a modern dairy barn because there are too many places where one can make mistakes that are costly in dollars and wasteful of chore time. Working plans are not presented in this publication, for lack of space. However, effort has been made to include diagrams and sections representing most general types of layouts, and for various sizes of dairy herds.

For detailed plans and answers to other planning questions, it is suggested that the local county agricultural agent or the Agricultural Engineering and Dairy Husbandry Departments of the College of Agriculture in your state be consulted.